THE AMERICAN GAS LIGHT JOURNAL

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

VOLUME LXIII.—No. 10. Whole No. 1,056. | NEW YORK, MONDAY, SEPTEMBER 2, 1895 | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager.
JOS. R. THOMAS, C.E., Editor. T. J. CUNNINGHAM, Asst. Editor.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

Published on each Monday of the year, at No. 32 Pine Street, New York.

Terms of Subscription, Including Postage—For the United States and Canada, $3 per annum. European countries, $4.50 (19 shillings—22½ francs). All payments to be made in advance. Single copies, 10 cents.

Remittances should be made either by post office order, express money order, registered letter, or bank draft on New York, payable to the order of A. M. Callender & Co.

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[OFFICIAL NOTICE.]

Twenty-third Annual Meeting, American Gas Light Association.

OFFICE OF THE SECRETARY, P. O. Box 1160,
PROVIDENCE, R. I., August 28th, 1895.

The 23d annual meeting of the American Gas Light Association will be held in the city of Philadelphia, Pa., on October 16th, 17th and 18th, 1895.

The headquarters and hall will be announced next week.

There are six first-class papers now listed to be read. The titles and names of authors will be given as soon as the papers have all been read and approved by the members of the Council.

Applications for membership must be indorsed by two active members and be received by the Secretary on or before October 5th, as if received later than that they cannot be constitutionally acted upon at this next meeting. Write to the Secretary for blanks and full information.

Questions for the Question Box should be sent to the Secretary as early as possible, as each one will be referred to some member, who will lead discussion on it, and so it is very desirable that sufficient time be given for proper investigation of the subjects.

In a few days the Secretary will send out the annual due bills, and it is hoped that the members will make their remittances promptly, by check or postal money order, payable to the American Gas Light Association, and not leave the matter till the meeting, as the collection of dues at that time causes very much hard work for the Secretary, which could be to a large extent avoided if remittances were sent by mail.

The Committee of Arrangements are busily engaged in the preparations for the meeting, and further notice will be given as the details of the programme are finally decided upon.

Respectfully, A. B. SLATER, JR., Secretary.

[OFFICIAL NOTICE.]

September Meeting, Society of Gas Lighting.

OFFICE OF THE SECRETARY, August 29th, 1895.

The September meeting of the Society of Gas Lighting will be held at the Arena, No. 39 East 31st street, New York, on Thursday, the 12th inst., at 3 P.M.

FRED. S. BENSON, Secretary.

BRIEFLY TOLD.

THE AMERICAN ASSOCIATION'S TWENTY-THIRD MEETING.—Preceding this mention is Secretary Slater's official announcement that the 23d annual meeting of the American Gas Light Association is to be brought off in Philadelphia during the third week of October; nor is he any too early in the field with his preliminary warning, for much remains to be attended to and directed, that all will be in readiness for a smooth and successful convention. The average member, as a rule, troubles himself not over much with thought respecting the planning and the plotting and the real labor—vexatious and commonplace, perhaps, rather than mystifying and weighty—coming to those having charge of the arrangements, when he seats himself in the convention hall and takes

his part in the proceedings, whether as a listener or as a debater. But just in proportion as the convention moves along smoothly, so may he appreciate that that smoothness has been attained only by the correct methods employed by those who, looking ahead, saw straight and prepared on equal lines for the result reached. Having calmly written down this homily, we may as well come to the point at once by saying that Secretary Slater's circular presents some hints that the "average" member ought to consider carefully and act upon speedily. For instance, those with queries to propound should send them along at once, so that expounders thereon may be found in due season; again, the business of the meeting, and the Secretary's relation thereto especially, may be simplified if dues are paid in the manner suggested by Mr. Slater. All who have attended the meetings must have, at one hour or another, seen a swarm of delegates striving to pay their dues at the Treasurer's desk, just at the time when the technical business of the convention was in full swing. Confusion and ill-temper at such times are unavoidable, and there is no necessity for either, simply by following the practice dictated by the commonest of common sense. Send your dues along, and send them early—the earlier the better. Those intending to take up membership in the Association might just as well be ahead with their applications; in any event the applications must be in hand by October 5th. The positive announcement that six first-class papers are listed to be read is more than pleasing, since it shows that the technical part of the programme is to be fully up to standard. As Philadelphia is a hospitable center, abounding in points and places of interest, and as the weather conditions there during mid-October are usually of the finest, it takes not a prophet to say that the American is in for a most enjoyable time.

SHALL THERE BE A DISPLAY OF GAS APPLIANCES AT THE PHILADELPHIA MEETING?—This topic is now being vigorously discussed by the Committee of Arrangements for the Philadelphia meeting, and it is to be hoped that an affirmative determination will be reached. We say, yes, unrestrainedly and unreservedly; for such displays are in the nature of a liberal education to the visiting gas man. We know that some, perhaps many, will differ with us in this respect, their objections resting largely on the idea that exhibitions of this nature heretofore given have been neither imposing nor coherent nor representative. It is true that their scope was not large, still we have no hesitation in saying that the narrowest of them must still be credited with having done some good. In connection with this we submit the following circular letter from the Committee of Arrangements:

OFFICE OF CHAIRMAN COMMITTEE OF ARRANGEMENTS,
DREXEL BUILDING, PHILA., PA.,
August 26th, 1895.

Dear Sir: This Committee[1] is about to decide whether—in connection with the convention above—to have, or not to have, the customary incidental exhibit or display of gas appliances, materials, stoves, tools, etc.

Some favor such an exhibit, on the score that it is expected, is educative, beneficial and of interest, especially to the visiting gas men from small companies, having few opportunities for seeing such appliances.

Others oppose it, on the ground that it is a very old story—a "chestnut"—that few of those in attendance care for or would really miss; that the time of the convention is too short to enable a really good display, or proper inspection of such, if provided; and that the supply men would welcome a convention without an exhibit arbitrarily arranged for in which they often feel they have to co-operate.

The Committee desires to decide in fairness to all, and feels that before deciding, the views of the supply men, who "pay the freight," should be learned. Hence this letter, to 50 representative firms. Will you kindly write me confidentially and frankly, as soon as possible, saying whether you favor an exhibit or not; and why.

Very truly yours, F. H. SHELTON, Chairman.

NOTES.—Work on the improvements at the St. Augustine (Fla.) plant is well underway. The tank for the new gasholder took a lot of piling. ——The Spring City Gas Company, of Royersford, Pa., had to sue the lessee, Mr. J. L. Kaler, for the rental named in the lease. Defendant asserted that the condition of the plant had been misrepresented to him by Secretary Rennyson, of the Company, prior to the drawing of the lease, and because of such misrepresentation he was obliged to spend a large sum in betterments. These allegations were denied by complainant, and Judge Urner ordered judgment for the latter.——The Hillsdale (Mich.) Gas Company has been put in charge of a receiver, because of a default in payment of interest on its mortgage bonds.——Mr. John Eastwood, formerly prominent in the affairs of the Hamilton (Ont.) Gas Company, died at his home in East Hamilton on August 25th. He was in his 58th year.

1. Committee of Arrangements for the 23d annual convention of the American Gas Light Association.

Notes on the Chemical Constitution of Illuminating Gas in Relation to its Illuminating Value, and on some of the Physico-Chemical Conditions which Influence the Luminosity of Gases.

[A paper read by Mr. W. Young, of Peebles, Scotland, at the 34th meeting of the North British Association of Gas Managers.]

The subject of my notes was first introduced to the notice of this Association some 20 years ago by our worthy member, Mr. MacPherson, of Kirkaldy, in a most interesting paper upon "The Relations which Exist between the Durability and Bromine Tests and the Illuminating Power of Gas as Expressed in Standard Candles;" and again at our meeting at St. Andrews in 1878, in a paper on "How should the Value of Gas be Determined?" In these papers it was shown that there appeared to be a proportionate relation between the hydrocarbons absorbed by bromine, the durability of a 5 inch flame, and the illuminating power; and that the illuminating power and the durability bore a fixed relation to the percentage of carbon present in the gas.

In the discussion which followed the reading of the latter paper, while admitting that, in the majority of cases, there was an approximate relation in all coal gases, as ordinarily manufactured, between the condensation by bromine, the durability of a 5-inch flame, and the illuminating power, such as to provide a ready method of approximately arriving at the probable illuminating power of a gas, I yet questioned the correctness of the inference that there was necessarily a fixed relation in those respects, or that the illuminating power bore a fixed relation to the percentage of carbon present in the gas. I pointed out that the illuminating power was far more dependent upon the mode in which the carbon was combined than upon the actual percentage present in a gas, and that the state of combination of the carbon also similarly influenced both the durability and the condensation by bromine.

At our next annual meeting, held in Edinburgh in 1879, I had the honor of reading a paper before you in further elucidation of the same subject, having for its title "The Proportion of Carbon Present in Gas in Relation to its Illuminating Power." In order to illustrate, in a striking way, the different effects, due to the structure of a gas in relation to its constituents, upon the relation between the condensation by bromine, the durability, and the illuminating power, I brought under your notice five different samples of gases, which, though all containing exactly the same quantities of carbon and hydrogen, yet possessed different volumes, and consequently differed in specific gravity and in durability, and also presented different degrees of condensation by bromine, and also differed largely in illuminating power.

The first sample consisted of methane or marsh gas (CH_4), which occupied a vessel containing 1,200 cubic inches, and, when consumed in a flat flame burner, was shown to give practically little or no light.

The second sample consisted of the same quantities of carbon and hydrogen as were present in the 1,200 cubic inches of methane, but arranged or grouped to form a more complex paraffine (C_6H_{14}) and free hydrogen. This, although it occupied the same volume, was shown to give, when consumed, a considerable amount of light; but it gave no condensation by bromine.

The third sample consisted of a like quantity of carbon and hydrogen arranged as ethylene or olefiant gas (C_2H_4) and free hydrogen. This, when so arranged, was shown to possess a larger volume—viz., 1,800 cubic inches. But although larger in volume, yet, on account of the different arrangement of the carbon with the hydrogen, the mixed gases, when consumed, give a highly luminous flame; and there was a very large condensation by bromine—a condensation far in excess of what would be proportional to the illuminating power.

The fourth sample consisted of the equivalent of the elements present in the 1,200 cubic inches of marsh gas, arranged to form acetylene (C_2H_2) and free hydrogen. When so arranged, the volume was doubled, becoming 2,400 cubic inches. Yet, although doubled in volume, and consequently having only one-half the specific gravity, and only half the durability through a given sized orifice, yet the mixed gas, when consumed, was shown to give a still larger amount of light.

The fifth sample consisted of the equivalent quantity of acetylene (C_2H_2) polymerized into benzol, and diffused in the form of vapor through free hydrogen. The carbon and the hydrogen equivalent to the 1,200 cubic inches of marsh gas, when so arranged, occupied 2,000 cubic inches. But, although occupying this much larger volume, it was shown, on being consumed, to give an intensely smoky flame; and, owing to the high vapor density of the benzol, the condensation by bromine would be small compared with the very high illuminating power.

Attention was then directed to the reason why carbon, in these different forms of combination, should give such discordant results; and

why, when combined with hydrogen as methane or marsh gas, it should give little or no light, while the same carbon, when combined as acetylene (C_2H_2), should give a flame having an intense luminosity.

The explanation then given was that the difference was due to potential in the form of heat energy stored up in the different hydrocarbon compounds; that carbon, when burned in, or combined with hydrogen, gives out heat just as when combining with oxygen, but to a much smaller degree; and that while the union of carbon, even with one atom of oxygen to form carbonic oxide, develops sufficient energy to gasify the carbon from the solid form, and leave a considerable surplus of heat, the union of carbon with hydrogen in the lower forms of combination does not yield sufficient energy even to gasify the carbon. Therefore, in such forms of hydrogen and carbon compounds energy must be supplied from some external source to bring about the union; and it is only when the carbon is combined with its full complement of hydrogen—as in marsh gas—that sufficient energy is developed to gasify the solid carbon and leave a surplus of heat energy.

It was also pointed out that Favre and Silbermann had found the energy of the combination of carbon with hydrogen to form the saturated hydrocarbon marsh gas (CH_4) to be not only sufficient to gasify the carbon and to effect the union, but to leave a *plus* or surplus heat of 20,420 heat units; and that, on the other hand, when the carbon was combined with a smaller percentage of hydrogen to form the unsaturated hydrocarbon olefiant gas (C_2H_4), there was no *plus* or surplus heat produced; that in the latter case the energy was not even sufficient to gasify the carbon, but that 10,880 heat units must be supplied from some outside source in order to effect the combination. Again, when carbon combined with hydrogen to form the still less saturated hydrocarbon acetylene (C_2H_2), there was required from some outside source no less than 55,000 heat units. That therefore the carbon, in combining with hydrogen to form olefiant gas and acetylene, had conferred upon it a higher potential or amount of locked up heat energy as compared with the carbon forming the marsh gas, of 31,300 and 75,430 heat units respectively; and that when these gases were burned, the extra amount of stored up energy in them would be developed as light and heat. It was further stated that these hydrocarbons (C_2H_4 and C_2H_2) were not so stable compounds as the marsh gas, and they were therefore more easily decomposed by heat into dense hydrocarbons and free carbon.

At the date at which that paper was read, I was fully under the impression that these, together with the influence of the different diluents present in the gas, were the main factors influencing the illuminating power resulting from the carbon in coal gas; and, under such an impression, I thought myself fully warranted in asserting that, while there was admittedly a relation between the physical and the chemical composition of coal gas, as ordinarily manufactured, on the one hand, and the illuminating power on the other, as shown by Mr. MacPherson, yet I considered that this was accidental, and that "if at any time the conditions which make a system of manufacturing gas successful in one district of country, from its locality, or it might be the nature of the coal or other material to be dealt with, rendered it not so successful as another, and called for an altered system of manufacture, this would, in a great measure, change the nature of the constituents of the gas, and consequently all the relations which experience has shown to exist between illuminating gas and the conditions referred to in this paper."

The conditions forecast in that statement have now, to a considerable extent, come about. Our supplies of cannel are becoming rapidly exhausted, while the supplies of liquid hydrocarbons are as rapidly expanding. The change in the supply of crude materials has developed new methods of producing and enriching illuminating gas. We have the water gas process, where the diluents carbonic oxide and hydrogen are mainly produced from the residual coke from our coal, and the illuminating power is conferred upon the gas by decomposing the liquid hydrocarbons. Such gas gives a small flame and a lower durability than ordinary coal gas. We have the carbureting of ordinary coal gas by diffusing through it the vapors of the highly volatile hydrocarbons, both from the natural petroleum and from the artificially prepared tars. By the former (petroleum enrichment), the flame is enlarged in proportion to its illuminating power, and the durability is increased. But bromine would scarcely effect any extra condensation, since the volatile petroleums are largely composed of paraffines. On the other hand, the benzol vapors would be entirely removed by bromine, and a small flame of lower durability would be produced. We have also the method of enriching coal gas by means of oils cracked up in various ways into gaseous compounds; and lastly, we have had lately brought under our notice pure acetylene as a possible enriching agent.

The introduction of these new processes and the materials for the production and enrichment of illuminating gas, has brought prominently under observation various chemical and physical conditions influencing the development of light from the flame of hydrocarbons, which conditions had either previously escaped observation, or had seemed of so little practical importance as to receive little attention. My connection with the process of enriching coal gas by means of oil gas, fractionally decomposed at low temperatures, has caused me to take special note of those physico-chemical conditions; and these notes, bearing as they do upon previous communications, I propose to lay before you today.

In my former paper, it was shown that those hydrocarbon gases which yielded flames having the highest luminosity were those having the highest stored up potential or heat energy. Professor Lewes, in a recent most interesting communication to the Royal Society, has shown that the illuminating value of a hydrocarbon gas, when consumed alone, may be approximately calculated from the heat of formation or stored up potential energy of the elements present in each hydrocarbon.

The following table, taken from Professor Lewes' paper, shows the relative calculated and found illuminating values from the two equivalents of carbon present in the following hydrocarbon compounds:

	Illuminating Value.	
	Calculated.	Found.
Methane	8.4	5.2
Ethane	35.0	35.0
Ethylene	60.9	68.5
Acetylene	202.2	540.0

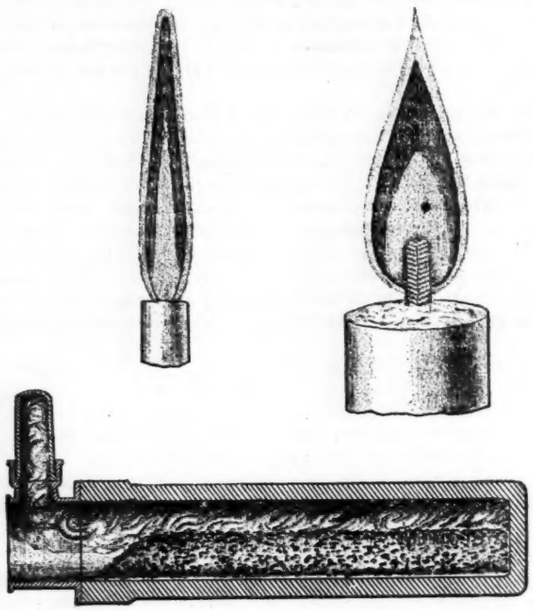
These figures fully confirm the inferences contained in my former paper, and, if taken alone, would indicate that in manufacturing gas we should, as far as possible, aim at the direct production from the crude material of those gases which possess the highest potential energy.

Although it is true, however, that hydrocarbon gases of high potential energy give the greatest luminous effect when consumed alone, and although, as shown by Professor Lewes, acetylene—one of those gases—plays a most important part in the ultimate luminosity of all hydrocarbon flames, it does not necessarily follow that, even were it possible to convert the whole of the volatilizable carbon in our crude material into acetylene, that acetylene would be the best hydrocarbon to form part of an illuminating gas, necessarily consisting, as it does in large measure, of non-luminous diluent gases; for recent experience with enrichment processes has shown that under such circumstances there are brought into operation a great many conditions which influence the light obtainable from a mixture of hydrocarbon and non-luminous gases.

The flame of a candle has frequently in the past been taken to illustrate and explain the method by which the luminosity of a hydrocarbon flame is produced. It has been pointed out how, in the flame of a lighted candle, we have all the conditions obtaining in the production of a coal gas flame, including both the cracking up of the hydrocarbon and the subsequent changes which occur during the combustion of the resulting gas.

With your permission, we shall revert to the subject. I have here a diagram of a candle, showing, as is generally done, three well marked zones. Around the lower part of the wick the melted hydrocarbon, or the fatty acid or tallow, is drawn up from the cup of the candle by capillary action, is volatilized, and a portion is consumed in forming a wall of flame which surrounds the higher parts of the wick, and supplies the heat necessary to volatilize the ascending hydrocarbons. The resulting vapors drive back the surrounding wall of flame, and, being subjected to the heat radiated from that wall of flame, are in part decomposed. The more diffusible portions of the products of decomposition pass to, and aid in forming, the outer flame wall. So far little or no light is produced, the heat generated having been consumed in the preliminary volatilization and partial decomposition of the hydrocarbon of the candle. The temperature of the flame now rapidly increases, and the volatilized and partially decomposed hydrocarbons continue to spread and ascend within the outer flame wall of complete combustion. They are then subjected to the heat radiated therefrom, and undergo further chemical changes, the chief of which, as shown to demonstration by Professor Lewes, is the conversion of the original hydrocarbon into acetylene, methane and free hydrogen. The methane, and more particularly the free hydrogen, from their greater rate of diffusion, pass out to the outer walls and are burned, thereby still further raising the temperature of the flame. This leads to the decomposition of the hydrocarbon of high potential, and thus light is produced, for the liberated carbon particles, heated by the liberated hydrogen, remain incandescent till finally consumed in the upper part of the flame.

Let us now apply this train of reasoning to our ordinary gas plant. We have here a diagram of a retort charged with coal as the source of the hydrocarbon supply. As this hydrocarbon contains a large excess of carbon over what can be volatilized, we take and burn a portion of this excess of carbon externally to the walls of the retort till these are heated to the temperature found best suited to bring about the desired



amount of decomposition. The coal resting upon the lower part of the retort has its hydrocarbonaceous portion volatilized. The vapors pass upwards into the vacant space over the coal, where they are exposed to the radiant heat of the arched walls and cracked up, as far as possible, into compounds which will remain gaseous. These gaseous compounds after being cooled and freed from accompanying impurities are passed to the burner to be consumed. The flame from such a burner is shown in the second flame diagram, which represents the cross section of an ordinary flat flame. As in the case of the candle, it consists of three separate parts—an inner cone of unconsumed gas, an outer complete combustion flame shell or wall, and an intervening cone in which the hydrocarbon gases are being acted upon by the heat radiated from the outer flame walls. Although, however, the gas flame appears to consist of three separate parts, the conditions obtaining within the inner parts are much less complex than those in the candle. The hydrocarbons are already in the gaseous form, having had the potential or heat energy of a part of the carbon burned outside the retort conferred upon them, and they are thus diffused through a large volume of diluent gas. This diluent gas would, in the case of the candle, be to a large extent consumed in the outer shell of the candle flame in doing the work of volatilizing and chemically changing the hydrocarbons preparatory to final rupture into their elements. In fact, the candle may be looked upon as a retort within a retort. The inner one consists of a wick supplying a continuous stream of hydrocarbon, which is volatilized by the combustion of a part of the hydrocarbon, supplemented by the radiant heat from the walls of the second retort. These second retort walls are composed of the transparent gases undergoing complete combustion. The intervening space is filled with the vapors from the wick, and these vapors are there subjected to chemical changes which set hydrogen free, which confer upon the altered hydrocarbons a higher potential of energy, and which finally bring about the decomposition of these hydrocarbons and their rupture into their elements.

We thus see one of Nature's ways of doing the carbonizing or retorting of a hydrocarbon when her object is to produce light by the combustion of that hydrocarbon in the form of a gaseous flame. On former occasions I have had the honor of drawing your attention to the important part radiant heat plays in the economical carbonizing of coal in the retort. I think the flame of a candle bears strong testimony to the soundness of that opinion. On the other hand, when Nature's object was to supply man with liquid hydrocarbons in the shape of petroleum, her retorting or carbonizing was done in a retort with no empty space in which radiant heat could effect the gasification of the hydrocarbons produced, and when man came to imitate nature in obtaining liquid hydrocarbons from soild coal and shale he was not long in discovering the gasifying effect of radiant heat in empty space inside the retort, and in devising a retort which had no empty space. That retort was then equivalent to the wick of the candle, surrounded by walls close to it heated externally, the volatilized products being prevented from escaping into space by being drawn off at the top of the wick and passed to the condensers. In like manner we may take a lesson as to how coal should be carbonized; that while contact heating may be economically employed to volatilize the hydrocarbon of the gas making material, the actual decomposition of the hydrocarbons should, as far as possible, be effected by radiant heat.

It will be observed that the essential difference between the production of light from a hydrocarbon by a wick-fed flame and that produced by the pre-carbonizing of a hydrocarbon in retorts together with a gas-fed flame, consists in the fact that such carbon as is present in the hydrocarbon in excess of what can be gasified is very differently utilized in the two cases. In the wick-fed flame the decomposition of the hydrocarbon is largely effected, first, by the complete combustion of a portion of the hydrocarbon in the lower part of the flame, and thereafter by the combustion of the hydrogen and marsh gas, as produced during the different stages of decomposition in the outer flame wall of the flame. The carbon set free takes a comparatively feeble part in the work of decomposition, for it is burned away only when it reaches the upper part of the flame, where most of the work preparatory to the final decomposition has been already effected. The carbon thus mainly contributes to the luminosity of the flame through the incandescence due to its own combustion.

Where the hydrocarbon is first carbonized, the carbon in excess of what can be gasified is isolated and burned outside the walls of the retort, and is therefore applied to the volatilizing and gasifying the volatilizable part of the hydrocarbon and conferring upon it a part of the heat energy of combustion in the form of stored-up potential energy. Then the liberated hydrogen and marsh gas, not being consumed as produced, are left to form a part of the gas and still further to raise the potential energy of the gasified hydrocarbon before final dissociation takes place in the flame. The stored-up or potential energy is instantly liberated when the hydrocarbons are decomposed into their elements, carbon and hydrogen, the result being, as we have already explained, the production of increased luminosity.

It will thus be seen that the method of obtaining light from a hydrocarbon by pre-carbonizing in retorts and combustion in a gas-fed flame possesses advantages over that of a wick-fed flame in so far that it enables better control to be maintained over the changes, chemical and physical, which ultimately result in producing light. In order, however to get the full advantage of the, so to speak, double retorting system with a gas fed flame it is necessary to adjust the relations between the potential energy conferred upon the volatile hydrocarbons while these are undergoing gasification within the heated walls of the retort, and the potential energy subsequently to be further conferred upon them by the chemical and physical changes which take place inside the flame walls during the second retorting process. The object is that at the final rupture or dissociation there shall be present in a flame as large a percentage of hydrocarbon of high potential energy (acetylene) as possible.

Different hydrocarbons require different temperatures in order to bring about that adjustment between the changes which it is desirable to effect in the prior retorting process and those which it is desirable should be subsequently brought about in the flame by the heat of the non-luminous gases unavoidably produced in the prior retorting process. Should the temperature of the prior retorting process be too high, changes are brought about within the retort which should only take place within the flame, carbon being precipitated there instead of being left as volatile carbon to be precipitated in the flame, and an excess of non-luminous heating gases is produced which cannot be devoted to bringing about beneficial changes in the accompanying hydrocarbons.

If, on the other hand, the hydrocarbons to be rendered gaseous by the prior retorting have to be used diffused through coal gas in order to increase its illuminating power, recent experience with oil gas enrichment processes has shown that, in consequence of the coal gas possessing a large surplus of potential or heat energy in its non-luminous or feebly-luminous constituents which can be economically employed in raising the potential energy of the hydrocarbons, the lower the temperature at which the hydrocarbons can be pre-retorted or cracked up, the greater is the percentage of carbon that can be permanently gasified and rendered available for carbureting. And although the hydrocarbon so gasified has less heat potential, the difference is nevertheless far more than counterbalanced by the utilization of the surplus heat

energy of the non-luminous portion of the coal gas in effecting chemical changes in the flame, and also by other physical conditions influencing the luminosity obtained from a given hydrocarbon. The surplus heat energy of a gas flame is similarly advantageously employed when the coal gas is carbureted by means of the vapors of very volatile hydrocarbons.

It has long been known that different non-luminous and feebly-luminous diluents—such as carbonic oxide, hydrogen and marsh gas—had very different effects upon the illuminating power of highly luminous hydrocarbons when diffused through them and burned; and that carbonic oxide had a greater diluting effect than hydrogen, and hydrogen a greater effect than marsh gas, even after making allowance for the original feeble luminosity of marsh gas. It is only, however, since the introduction of the various carbureting processes that it has been observed that not only had the various diluent that difference of effect, but that different hydrocarbons were also very differently influenced in their luminosity by being diluted with the various diluents referred to, including coal gas; that while oil gas, produced at low temperatures, when commingled with certain percentages of diluents, gave an aggregate luminosity largely in excess of what could be obtained from the undiluted gas—or, in other words, was benefited by dilution—oil gas, produced at high temperatures, as also acetylene gas, when diluted to a like degree, were not benefited to the like extent; or, as in the case of acetylene gas, gave a luminosity very much less than could be obtained by the combustion of the pure gas.

It has also been observed that hydrocarbons having the same percentage of carbon and hydrogen in their composition, but differing in density, are very differently effected by diluents; and that the denser the compound, the greater is the enriching value per unit of carbon present. Thus the 6 atoms of carbon associated with 6 atoms of hydrogen in the 3 molecules of acetylene had not the same enriching value as the same number of carbon and hydrogen atoms, equivalent to 3 molecules of acetylene, but polymerized into one molecule of benzol.

To enable us to follow the manner in which the various forces operate during the combustion of a hydrocarbon so as to bring about those observed results, we must again refer to the structure of the gas-fed flame, the action of which I shall again ask you to look upon as a carbonizing or retorting process. The walls of the retort are composed of the products of complete combustion of the constituents of the hydrocarbons, and are practically transparent to the ethereal waves of light generated by the chemical changes which occur within the flame. These chemical changes are brought about by the radiant heat from the intensely heated gaseous walls of the flame-retort.

On a former occasion, at a meeting of the kindred Association now merged in this, I drew attention to the influence of the force of diffusion of gases during the carbonization of coal inside a clay retort, and showed how the porous walls of the clay retort allowed an exchange of the gases inside the retort and those outside it, at rates proportional to the square root of their respective densities. Now, although the wall of our combustible retort is composed only of highly-heated gases, yet that gaseous wall will nevertheless exercise a similar effect, though a modified one, to that exercised by the porous walls of the clay retort; and the more perfectly this outer flame-wall is maintained by a careful regulation of the pressure of the gas at the point of ignition, so as to prevent induced currents of air or gas, the more perfectly will this outer flame-wall take upon itself the function of a previous diaphragm in influencing the action between the combustible gases inside and the supporters of combustion outside; and the more perfectly will it also act in other respects as the wall of a retort, in the manner to be immediately brought under your notice.

The relative affinities for oxygen of the various constituents of the illuminating gas have also to be taken into account; for although the outer flame-wall of the retort may, by carefully regulating the pressure of the gas at the burner, be made to act fairly effectively, yet some oxygen will always be carried into the interior of the flame, and those constituents of the compound gas which have the greatest affinity for oxygen, under the conditions obtaining within the flame, will be the first to seize upon such intruding oxygen.

Professor Clowes recently communicated to the Federated Institute of Mining Engineers the results of a series of experiments in which flames were burned in an inclosed volume of air, maintained at atmospheric pressure, till each flame was extinguished by the products of its own combustion, and the atmosphere that had extinguished each flame was then analyzed. The results showed that a paraffine flame was extinguished when the oxygen fell to 16.6 per cent.; a candle flame, 15.7 per cent.; a methane flame, 15.6 per cent.; a carbonic oxide flame, 13.35 per cent.; and a coal gas flame 11.35 per cent.; while a hydrogen flame was not extinguished till the oxygen present fell to 5.5 per cent. The conditions under which these tests were made, being very much those obtaining in a gas-fed flame, will in all probability indicate the relative affinities for oxygen of the substances named.

As the heat which effects the work of altering the chemical constituents of the hydrocarbon gas is necessarily largely radiant heat, from the outside highly heated gaseous wall of the flame, the power of the constituents of the gas to respond to, or take up, this radiant heat will, of necessity, considerably influence the resulting changes which occur within the flame.

I have already explained to you my views with regard to the selective action of radiant heat upon the hydrocarbon vapors evolved from the coal inside a gas retort; how the radiant heat from the walls of the retort passes freely through the simple gases, but is more and more freely absorbed as the hydrocarbons become more complex in their constitution. Although, however, the simple gases cannot readily respond to, and be heated by, radiant heat, they have the power, when commingled with complex hydrocarbons, of largely modifying the effect of radiant heat upon these, by taking up the molecular motion or heat absorbed by the complex hydrocarbons, and becoming themselves heated by contact.

There is no doubt that the heat radiated from the gaseous highly-heated flame-wall acts upon the constituents of the gas in the interior of the flame in a very similar manner. The power which the hydrocarbons possess of taking up the radiant heat enables the long heat waves from the flame-wall to effect changes which confer potential energy upon the hydrocarbons, and this results, at the moment of ultimate decomposition, in the production of short waves of light.

The interactions between the hydrocarbons in the gaseous flame have, no doubt, also a considerable influence upon the luminosity of a flame. These interactions are not well understood, but Prof. Lewes has shown that whatever the original hydrocarbons may be, they are very largely converted into acetylene before undergoing final dissociation into their elements. There is little doubt, however, that, both in the process of cracking a hydrocarbon inside a retort, and also during the cracking up and changing the hydrocarbons into acetylene in the interior of a gas flame, both hydrogen and carbon are partially set free without passing through the acetylene stage; and it has occurred to me that this free carbon is itself largely conducive to the formation of acetylene and other hydrocarbons of high potential energy, and that even the carbon set free from the dissociation of the acetylene may take part in the subsequent changing of the methane produced at the time of the formation of the acetylene from the other hydrocarbons. For instance, methane and ethane have a low potential of stored up energy, and they produce, when burned, a small amount of light in proportion to the carbon which they contain. Both these gases, especially the former, may be passed through a length of empty tube heated to a high temperature. In that case only a very small portion undergoes decomposition, and that principally at the surface of the tube. This is due to the fact that the radiant heat from the walls of the tube is only feebly absorbed by such gases, and cannot, therefore, readily effect any decomposition. If, however, the tube be filled with a solid substance, such as graphite or pounded retort carbon, presenting a large surface which can take up the heat and be raised to a high temperature, the gases, on being passed through, are then largely decomposed—the carbon of their constitution being left behind on the highly heated solid surface. Contact heat has thus effected what radiant heat had failed to accomplish.

The conditions obtained when methane is burned alone are exactly analogous to those of methane passed through the highly heated tube. The outer highly heated walls of the methane flame radiate heat through the methane contained in the interior of the flame. Methane, however, is but feebly acted upon by radiant heat; and only a very small portion is brought into the condition necessary for the production of light.

If the methane has diffused through it some other hydrocarbon which possesses, in a high degree, the power of absorbing radiant heat, and is therefore readily decomposed, conditions are brought about exactly analogous to those in the highly heated tube filled with solid material, for the radiant heat from the hot flame-walls, falling upon the carbureting hydrocarbon, is absorbed by it and causes it to undergo changes which ultimately lead to its dissociation into its elements. The solid particles of carbon thus set free, being also good absorbers of radiant heat, become highly heated, and the methane in contact with these highly heated particles is acted upon by the contact heat, which thus brings about those conditions in the flame which lead to increased luminosity.

It will thus be seen that, while the action of contact heat by surface is highly advantageous in the flame (setting free carbon to produce luminosity), the same action inside a gas retort would be highly objectionable, as it would rob the hydrocarbon gases of carbon which should only be set free in the flame.

The chemical changes which are brought about in different hydrocarbons by contact heat are no better understood than the changes induced by radiant heat. As already stated, Professor Lewes has shown that, in whatever way the changes are brought about, most of the hydrocarbons contained in a flame are converted into acetylene before final dissociation into their elements; and that, if the changes are arrested after the change into acetylene has taken place, the acetylene polymerizes mostly into hydrocarbons belonging to the benzol group. Dr. Dvorkovitz has also shown that a potent factor in changing hydrocarbons belonging to the paraffine and olefine groups into the benzol group by heat, is surface contact. These two facts, taken together, would point to the solid particles present in a flame playing an important part in bringing about the chemical changes therein which lead up to luminosity, and would at least partly explain why the commingling with hydrocarbons of low potential—such as methane—of hydrocarbons which have a high power of absorbing radiant heat, and are easily decomposed, with the liberation of free carbon particles, leads to the apparent high enriching value of the latter when diffused through the former.

There are two theories as to how the luminosity of a hydrocarbon flame is brought about. One is that of Sir Humphry Davy, that the luminosity of a hydrocarbon flame is solely due to the solid particles set free from the decomposition of the hydrocarbon in the flame, and heated to incandescence; the other, that of Dr. Frankland, who challenged the solid particle theory, and showed that flames of some substances, which could not possibly contain solid particles of any kind at the temperature of the flame, but whose vapors were very dense, produced highly luminous flames. Dr. Frankland further showed that substances yielding flames that were non-luminous, or feebly luminous, under ordinary atmospheric pressures, became highly luminous when burned under high pressure, and he inferred therefrom that the luminosity of the flames of hydrocarbons was due to the incandescence of extremely dense hydrocarbons in the flame.

While satisfied that the luminosity of hydrocarbon flame may be partially brought about in accordance with both theories, neither of these fully accounts for some of the observed results previously referred to; and it has occurred to me that an explanation may be found in supposing that, at the moment of decomposition or dissociation of the molecule within the flame, the decomposition or dissociation enables the molecule to shake the surrounding ether into waves of light, and that this power can be conferred upon molecules either by stored-up energy, as in the case of hydrocarbons like acetylene, or still further by densifying such hydrocarbons by polymerization, or even by mechanical condensation or pressure, as is the case when non-luminous gases are burned under high pressure with the evolution of light.

In other words, just as, by raising the temperature of solid substances by means of non-luminous heat, a power is developed in them of transmuting the long heat waves into short light waves, so the hydrocarbons in a flame can be so changed in their physical and chemical condition, by the stirring up of the non-luminous heat energy in the molecules of the hydrocarbon or in densifying the molecules, so that, when they come to be decomposed or dissociated into their elements, they can convert the stored-up energy of the long heat waves into light waves; and, again, by burning non-luminous gases under great pressure, the mechanical energy expended upon the densification of the gas confers upon the molecules the power of emitting light at the instant of dissociation in the flames.

The energy of the high temperature heat, when expended upon heating up carbon, enables the vibrating carbon to transmute the long heat waves into short waves of light. The carbon so heated communicates its heat to whatever may be brought in contact with it; and therefore a flame which owes its luminosity to solid particles will emit light dependent upon its temperature—such temperature being measurable by thermometric instruments.

The energy of the radiant heat, when expended upon effecting chemical changes in the hydrocarbons, is converted into stored-up molecular energy in the hydrocarbon compounds of high potential energy. Such stored-up energy becomes latent, and is not sensible to thermometric instruments; and it does not necessarily assume the form of heat of high temperature in order to produce light. According to the latter supposition or theory, it does not do so, but is largely converted directly into light at the instant of dissociation, and never becomes measurable by thermometric instruments.

It so happens that, in the case of hydrocarbons, the stored-up molecular energy, liberated at the instant of dissociation, is necessarily accompanied by the liberation of solid carbon. That solid carbon may take part in the conversion of the stored-up energy into light. But the fact, demonstrated by Frankland, that flames may be highly luminous in the absence of solid particles, makes it highly probable that the stored-up energy of the hydrocarbon is transferred to the ether by the carbon while still in the state of vapor, and that the action of the solid carbon particles is largely confined to the part of taking up the non-luminous heat radiations, and transmuting their energy into that of light. The fact that the luminosity of the flame from the combustion of hydrocarbons can be calculated, as shown by Professor Lewes, from their heat of formation or stored-up energy, also points in a like direction.

Professor Lewes has carefully tested, with very delicately-constructed instruments, the temperatures of the various portions of the flames of acetylene, ethylene and coal gas, with the following results:

Portion of Flame.	Acetylene.	Ethylene.	Coal Gas.
Non-luminous zone	459° C.	952° C.	1,023° C.
Commencement of luminosity	1,411° C.	1,340° C.	1,658° C.
Near top of luminous zone...	1,517° C.	1,865° C.	2,116° C.

These gases, when consumed in the burner best suited for their combustion, give the following illuminating values:

Acetylene	240.0 candles.
Ethylene.....	68.5 "
Coal gas.....	16.8 "

It will be observed that, when tested by thermometrical instruments, the gases as they rise in stored-up molecular energy, which can largely be directly converted into light at the instant of dissociation, give flames of lower and lower temperatures; but, when tested by the photometer, the emitted light rises as the molecular energy rises.

In the case of coal gas largely composed of non-luminous or feebly-luminous gases, with only a small quantity of hydrocarbons upon which the heat energy of the non-luminous gases can act in conferring the power of transmuting their heat energy into radiant heat and light, the flame retains its high temperature and heats up the part of the thermometric instrument inserted in it to a temperature approximately equal to its own.

By carbureting the coal gas, or by supplying the coal gas with a Welsbach mantle, we should enormously increase the light through giving the non-luminous gases something upon which their heat energy can be expended in transmuting the heat of the flame into radiant heat and light. But in both cases the temperature of the flame would fall.

As we have seen, ethylene possesses a certain amount of stored-up potential energy in excess of that of its separate elements. But, as shown by Professor Lewes, before undergoing final decomposition into its elements in a flame, it has to undergo a change into acetylene, and this involves the work of splitting off so much hydrogen. The heat resulting from the combustion of this free hydrogen will be partly expended in bringing about the chemical changes into acetylene, the dissociation of which produces light, and in heating up the liberated carbon and conferring upon it the power of radiating light and heat. Thus the temperature of the flame is kept lower than that of the coal gas flame.

Acetylene possessing a high potential energy, on undergoing decomposition or dissociation into its elements in the flame, has that stored-up energy largely converted directly into light, and since the liberated hydrogen is small in quantity, the energy developed by its combustion can be, in proportion, more fully expended upon the carbon in endowing it with the power of radiating light and heat. The temperature of the flame is thus kept comparatively low, while the flame itself emits much light.

It would therefore appear that, if it is desirable to develop the energy evolved by the combustion of a hydrocarbon or compound gas (of which the constituents are decomposable or dissociable by heat) so as to produce a flame of high temperature, it is necessary, in order to prevent that inter-molecular work being done, that the supporter of combustion should be intimately commingled with the decomposable gas, so as to prevent decomposition or dissociation of the hydrocarbons into their elementary condition prior to their complete combustion, and also that the combustion should be as rapid as possible.

With regard to the observed difference in color between the various hydrocarbon flames—as, for instance, between the white light from the low temperature flame of acetylene and the comparatively yellow flame of ethylene—it has occurred to me that the difference may be due to the relative proportions of light coming from the several sources of the

flame; that the stored-up energy in the hydrocarbon is directly evolved at the instant of dissociation as white light, while the light subsequently emitted by the liberated carbon varies in color according to the temperature of the flame; and that, further, as carbon is one of the elements that can assume various allotropic forms, and has also the power of holding in association with iself small quantities of hydrogen at extremely high temperatures, the carbon liberated from the various hydrocarbons may be under different conditions or forms, and may also hold in association varying proportions of hydrogen, which will confer upon it different powers of taking up non-luminous heat at a high temperature and transmuting it into light. The aggregate light produced would then have different colors, much in the same way that incandescent mantles give different colored light, dependent upon their constituent elements.

The deductions to be drawn from these notes are:

1. That, when a solid or a liquid hydrocarbon has to be converted into illuminating gas, the cracking up or carbonizing process inside the retort should be done at such a temperature and under such conditions as will produce the largest percentage of gaseous hydrocarbons suitable for the purpose of taking up the heat of the non-luminous gaseous part of the flame, and utilizing that heat in the production of changes which enable that non-luminous heat to be transmuted into light, and that radiant heat plays an important part in bringing about those changes, both in the retort and in the flame.

2. That non-luminous gases act in two ways: (1) While in contact with the hydrocarbons in the body of the flame they withdraw heat from the hydrocarbons which have the power of absorbing the non-luminous radiant heat from the flame walls. They thus retard or prevent those changes which lead to the storing up of the radiant non-luminous heat in the hydrocarbons, and they also tend to prevent the final dissociation of those hydrocarbons into their elements, and thus tend to cause loss of luminosity. The power of diluents to retard chemical change in the flame appears also to be influenced by the specific gravity or density of the diluting gas, the diluent of greatest density having the greatest retarding influence. (2) On reaching the outside of the flame the combustible diluent gases evolve heat, which is capable of bringing about those changes conducing to luminosity which they retard or tend to prevent while in the body of the flame.

It is the balance of these two effects which decides whether the luminosity of a hydrocarbon will be increased or diminished by dilution with non-luminous combustible gases. When the hydrocarbons possess the power of absorbing non-luminous radiant heat, and of being thereby converted into hydrocarbons of high potential energy, they are capable of being largely benefited by combustible dilution, especially with hydrogen or methane. On the other hand, with hydrocarbons such as acetylene, which cannot, in the gaseous state, have a higher potential conferred upon them by radiant non-luminous heat, diluents reduce the illuminating power of the hydrocarbon.

3. That the non-luminous flame-wall of a luminous flame performs the functions of the hot wall of a gas retort, in so far as it acts as a pervious separator between the carbureted gases inside the flame and the external air, and that radiant heat from the flame walls brings about similar changes inside the flame to those inside the retort—the essential difference being that, as the flame walls are transparent, they allow of the resultant luminosity being seen, and the evolution of light.

4. That the effect of diluents upon hydrocarbons is considerably modified by their specific gravity or rate of diffusion, and by their affinity for oxygen. Thus hydrogen, although volume for volume it produces about the same amount of heat at nearly the same temperature as carbonic oxide, is by far the better diluent, owing to the fact that, from its high rate of diffusion, it rapidly finds its way from among the hydrocarbons to the outside of the flame; and thus its injurious action inside the flame is greatly lessened, while the useful heating effect is brought more effectively into action. The high affinity of the hydrogen for oxygen also enables it to take hold of any oxygen which may have found its way into the flame, and thus to prevent the premature destruction of the hydrocarbon. The specific gravity of hydrocarbons has a similar influence. Thus acetylene, having a specific gravity approaching that of carbonic oxide, will, by diffusion, pass to the outside of the flame even more quickly than that diluent, while benzol vapor, having three times the gravity, will diffuse much more slowly, and will therefore remain longer within the body of the flame under the influence of the heated flame walls, and so will produce a greater amount of light.

5. That the free carbon present in a luminous flame, being heated by radiant heat from the outside walls, acts by surface contact in bringing about changes of the hydrocarbons, especially of those which have a low absorptive power for radiant heat, such as marsh gas. This leads to increased luminosity of the flame.

6. That the stored-up energy in hydrocarbons such as acetylene, and still more in polymerized acetylene in condensed molecules, such as benzol, etc., is liberated or given out, at the instant of their decomposition or dissociation, largely as light, and in great part never takes the form of heat; and that while the energy, radiated away in the form of light, can be measured by the photometer, the temperature of the flame, as measured by thermometric instruments, is low.

7. That the differences observed between the colors of hydrocarbon flames may arise from three causes: (1) The stored up energy in the molecules of hydrocarbon is directly emitted as white light; (2) the light emitted by incandescent carbon varies in color according to the temperature to which it is raised; and (3) the last is probably modified by the allotropic state the carbon may assume at the instant of dissociation from the hydrogen, and also by the small quantity of hydrogen held in union with it, either chemically or physically.

The subject of these notes is at present receiving a large amount of attention, and, had time permitted, I should have liked to go more fully into details on several points referred to, and necessarily omitted, more particularly into the influence of the different forms of burners, and of the pre-heating of the air supply upon the conditions which affect the production of light from illuminating gas. The paper has, however, already assumed dimensions which, I am afraid, have taxed your patience to the utmost. Besides, my main object in recurring to the subject of my notes was to explain why hydrocarbon gases and vapors having the same illuminating power when consumed alone, should have such different enriching values; and why oil gas produced at low temperatures should have a higher enriching value than a gas from the same oil cracked up at a high temperature, more particularly when commingled with water gas; and I trust that what I have been able to communicate has not only satisfied you upon that point, but also added somewhat to our general knowledge of the conditions influencing the luminosity of hydrocarbon flames.

[Translated from *Revue Industrielle*, by Mr. Herman Poole.]

On the Economy and Future of Motors, Driven by Explosive Mixtures.

Mr. C. Lambette, Chief of the Technical Service of the Belgian Society of Economic Motors, read before the Association of Liege Engineers a communication on the gas and petroleum motors shown at the Exhibition at Anvers in 1894.

This communication, which has been published in full in the *Revue Universelle des Mines et de la Metallurgie*, contains, among other interesting statements, a parallel between several thermic motor forces—gas, petroleum and steam. The author supposes that the installation was made at Brussels, and he examines from the beginning the case of the production of small power.

	Two-Horse Power.
1. *Gas Motor:*	
Price of motor, complete and set up	$350.00
Amortissement, interest, running expenses per year	51.30
Per Day:	
Maintenance, interest, amortissement	$0.171
Attendance, cleaning, oiling	0.237
Gas, 70.6 cu. ft. per hour, or 706 cu. ft. per 10 hours	0.380
Total	$0.788
(Equal to 3.9 cents per horse power per hour.)	
2. *Petroleum Motor:*	
Price of motor complete and set up	$380.00
Amortissement, interest, running expenses per year	57.00
Per Day:	
Maintenance, interest, amortissement	$0.190
Attendance, cleaning, oiling	0.285
Petroleum, 26.40 lbs. per hour, at 0.95 cent per lb.	0.228
Total	$0.703
(Equal to 3.5 cents per horse power per hour.)	
3. *Steam Motor:*	
Engine complete, set up	$380.00
Amortissement, interest, running expenses per year	57.00
Per Day:	
Maintenance, interest, amortissement	$0.190
Attendance, cleaning, oiling	0.665
Coal, 220 lbs., at $2.85 per ton	0.285
Total	$1.140
(Equal to 5.7 cents per horse power per hour.)	

TEN-HORSE POWER.

1. *Gas Motor:*

Motor complete, set up	$760.00
Amortissement, interest, running expenses per year	114.00
Per Day:	
Maintenance, interest, amortissement	$0.38
Attendance, cleaning, oiling	0.38
Gas, 2,470 cubic feet, at 54 cents per 1,000 cubic feet	1.33
Total	$2.09

(Equal to 2.1 cents per horse power per hour.)

2. *Petroleum Motor:*

Motor complete, set up	$950.00
Amortissement, interest, running expenses per year	142.50
Per Day:	
Maintenance, interest, amortissement	$0.475
Attendance, cleaning, oiling	0.475
Petroleum, 100 lbs., at 0.95 cent per lb	0.950
Total	$1.900

(Equal to 1.9 cents per horse power per hour.)

3. *Steam Motor:*

Engine complete, with condenser, set up	$1,140.00
Amortissement, interest, running expenses per year	171.00
Per Day:	
Maintenance, interest, amortissement	$0.57
Attendance, cleaning, oiling	0.76
Coal, 5,500 lbs., at $2.85 per ton	0.71
Total	$2.04

(Equal to 2 cents per horse power per hour.)

FIFTY-HORSE POWER.

1. *Gas Motor, Supplied with Poor Gas:*

Motor complete	$1,900.00
Dowson apparatus	1,140.00
Foundation and installation	380.00
Maintenance, interest, amortissement	513.00
Per Day:	
Maintenance, interest, amortissement	$1.71
Coke, 1¼ lbs. per effective horse power per hour, at $4.75 per ton	1.90
Oil	0.19
Attendance and cleaning	0.95
Total	$4.75

(Equal to 0.95 cent per effective horse power per hour.)

2. *Steam Motor, Jacketed, with Condenser and Variable Cut-off:*

Engine, complete	$1,330.00
Tubular boiler	855.00
Pipes and installation	380.00
Foundation	285.00
Chimney	285.00
Total	$3,135.00
Maintenance, interest, amortissement per year	470.00
Per Day:	
Maintenance, interest, amortissement	$1.57
Coal, 3.3 lbs. per effective horse power, at $2.85 per ton	2.14
Oil	0.19
Attendance and cleaning	0.95
Total	$4.85

(Equal to 0.97 cent per effective horse power per hour.)

We see, therefore, that the petroleum motor is the most economic up to 10-horse power, for which the price per horse power is about the same for gas, petroleum or steam. Beyond that size the steam motor is more advantageous, at least if it is necessary to run continuously and for a long time. The consumer must always make his gas if he wishes to employ a gas motor. For 50-horse power the cost of a day's work is the same with gas from coke or with steam; but it is clear that if we are situated in close proximity to anthracite mines, the advantage will be in favor of gas motors, these not requiring more than 1½ pounds of anthracite per horse power, while a steam motor needs 3.3 pounds of coal.

THE FUTURE OF GAS MOTORS.

In order to show what may be the future of the gas motor, Mr. Lambette formed a table of coefficients of economy of the heat motors in question. We know the economic coefficient may be expressed by the formula:

$$R = \frac{Q - q}{Q},$$

Q being the quantity of total heat of the combustible, $Q - q$ being the quantity of heat utilized. Again:

$$R = \frac{T - t}{T},$$

T being the absolute maximum temperature of combustion, t the absolute minimum temperature of the condenser, the changes of heat taking place at a constant temperature and the changes of temperature occurring without a change of heat.

For a steam engine working at 90 pounds pressure in the boiler, and at 1.5 pounds in the condenser—

$$R = \frac{(159 + 273) - (46 + 273)}{159 + 273} = \frac{26}{100}.$$

The real effect calculated will be 17 per cent. For a gas motor with previous explosion, the maximum calculated power, according to Mr. Witz, will be 38 per cent. With a consumption of 24.5 feet of gas of 5,400 calories per effective horse power, the real effect would be:

$$R = \frac{75 \times 3{,}600}{0.7 \times 5{,}400 \times 425} = 17 \text{ per cent.}$$

With a consumption of 0.88 pound of petroleum of 10,000 calories per effective horse power, the effect is $R = 12$ per cent.

With a consumption of 1.3 pounds of anthracite, of 7,500 calories per effective horse power, the effect is $R = 14$ per cent.

With a consumption of 1.76 pounds of coke, of 7,000 calories per effective horse power, the effect is $R = 12$ per cent.

These figures seem to show that the steam engine and the gas motor using illuminating gas hold the first rank from an economic point of view; this would be true if we found the gas and the steam in the natural state. But for a practical examination of the question we must return to the fuel; that is to say, to the coal of the boilers and the coke of the gas. Admitting that a steam engine consumes on the average of 2.2 pounds of 8,000 calories per hour per effective horse power, the actual effect will be:

$$R = \frac{75 \times 3{,}600}{8{,}000 \times 425} = 8 \text{ per cent.}$$

On the other side, 2.2 pounds of gas coal, with a calorific power equal to 8,500 calories, gives 9.8 cubic feet of gas of 5,400 calories per 35.3 cubic feet, allowing 1,500 calories for gas and 0.66 pound coke for the gasogene, the coke being 7,000 calories for 2.2 pounds, making 2,100 calories for the coke. So that of the 8,500 calories of the gas coal, 1,500 + 2,100 = 3,600 calories are used up in the service of the motor. Seventeen per cent. of 1,500 = 255 calories employed, 12 per cent. of 2,100 = 252 calories employed, making 50 per cent. of the 3,600 calories contained in the combustible gas and coke, and of the 8,500 calories of the 2.2 pounds of coal it forms 6 per cent. of the total calorific power.

We see that the working of the retorts is not satisfactory for the utilization of calorific power, for while the coefficient of utilization of the gas motor is 17 per cent.—that is to say, the highest of those which have been tried—we have only 6 per cent. of actual utilization; practically in the large installations there is not so much actual loss as the bye-products are utilized.

The combustion of coal to heat the steam generators does not show much better, for if the coefficient is 17 per cent. when we consider only the steam engine, it is but 8 per cent. if we add the boiler, and there are no bye-products. The gasogenes give better results, as was predicted, the number of transformations of the energy being less. This number is restricted in the petroleum motor, and thus explains its good effect.

Conclusion.—The gas motor has the highest economic coefficient; it is subject to improvement so long as theory assigns an effect of 38 per cent. These improvements will be obtained by improving the cycle of the motor and the gasogenes which are intimately connected with it.

Tests of Cut and Wire Nails.

At a meeting of the American Society of Mechanical Engineers, Professor R. C. Carpenter read a paper on experiments made in testing cut and wire nails. Among other things, the author remarked that the experiments show the force required to drive and start the nails and also the relative work in each case. To obtain some figures which

would give not only the maximum force, but also the work required for both driving and pulling various nails, the Professor had the following experiments conducted in the laboratory of Sibley College. Nails of various kinds were forced into a piece of Southern pine, which was as nearly homogeneous as was possible to obtain, by one of the heads of a testing machine, and the amount required at the end of each ¼-inch of penetration was noted. The nails were driven within about ¼-inch of their full length in each case.

In pulling they were drawn out by a species of forceps attached to the testing machine, the force required being noted at each ¼-inch. Diagrams were then drawn corresponding to the force exerted and the depth of penetration, the integration of these diagrams giving the total work either for driving or for drawing. Experiments were made on ten nails of each kind, and the averages taken to represent the work of any particular class.

A general summary of the experiments showed: 1. That very much more force is required to drive a cut nail a given distance than a wire nail. 2. That more force is required to start a cut nail generally than to drive it, and that it invariably starts much harder than a wire nail. 3. The work in inch-pounds per nail required in driving cut nails is much more than that in driving wire nails. 4. The work in inch-pounds in pulling cut nails is about equal, sometimes greater, per nail than that for pulling wire nails. 5. The maximum force per pound in driving or starting wire nails is more nearly equal to that of cut nails than when estimated on the basis of that of a single nail, but it is still less. 6. The work in foot-pounds per pound of wire nails required for driving is less than that required for the cut nail, and that for pulling is considerably more. 7. The relative efficiency which is here considered as the ratio of the work of pulling to that of driving is much higher for the wire nail than for the cut nail.

In making experiments it was noticed that the cut nail bruised and broke the fibres of the wood, principally at the end of the nail, whereas the wire nail simply crowded them apart and probably did not move them much beyond the point from which they would return by elastic force, and hence the nail would be grasped much stronger per unit of area of surface by the wood. Presenting less surface there would be, however, less resistance to starting.

To see what the effect of change of form would be, a number of tenpenny cut nails were sharpened on the point by grinding to an angle of about 30°, so that the fibers in advance of the nail would be thrust aside and not bruised and broken. This served to increase the holding power of the cut nail of ordinary shape about 50 per cent. in starting force and about 30 per cent. in work of resistance to pulling.

The good result produced in sharpening the end is shown by some experiments made some years ago in the Sibley laboratories on the holding power of ordinary railroad spikes, as compared with a Wolcott spike, which differed from the ordinary spike in having a sharp end and also in having two longitudinal grooves stamped into one side.

The Coal Fields of Manitoba.

According to Dr. G. M. Dawson, Director of the Canadian Geological Survey, the known area of true and lignite coals of the best quality extends along the base of the Rocky Mountains from the 49th parallel to the vicinity of Peace river, a distance of 500 miles, with an average width of, say, 100 miles, giving a total area of 50,000 square miles. It is not intended to affirm that the whole of this area is continuously underlain by coal, but outcrops of coal are so general throughout it that, taken in connection with the character and the regularity of the strata, it may safely be stated that it is throughout a coal field. An additional area, stretching eastward as far as the Souris river and Turtle mountains, yielding lignites only, but these often of very good quality and well fitted for local uses, may be roughly estimated at 15,000 square miles. These fields, owing to the limited demand for their produce, have hardly been touched as yet; but, when the scarcity of timber over a great part of the area in question is considered, it is evident that their existence is of the greatest moment in relation to the future settlement of the Northwest.

The areas within the Rocky mountains, though small as measured by miles, contain much coal of the best quality. One of these areas, on the Bow and Cascade rivers, has been found to hold several good seams of anthracite of good quality. The principal of these are at Marsh Mine, near the south end of the field, 1¼ miles from the main line of the Canadian Pacific Railway, and 550 feet above its level. Two thick seams of coal are found, one 17 feet (with 15½ feet coal) and the other 9½ feet (with 8½ feet coal) in thickness. About three miles to the northwest of Marsh Mine and about a mile from the railway there are eight openings into outcrops of workable seams. Six of these are apparently one above the other, containing 30 feet coal. At Canmore, about a mile from the railway station, and about 100 feet above it, there are three seams—one 4 feet, another 12½ feet, and the third 16 feet in thickness. At Anthracite, close to the railway, these seams are being worked respectively 6 feet (4½ feet coal), 3½ feet (3 feet coal), and 5½ feet (4 feet coal), in thickness; at Moberly, which is near the northwest end of the field, there is a seam of coal 4½ feet thick (3 feet 8 inches coal). Two of these seams near Canmore are vertical, apparently from some disturbance, but with these exceptions they all dip to the southwest at angles ranging from 12 to 60°. The relation of the various outcrops to Canmore mines can best be ascertained by drifting.

These mines were opened first by the Canadian Anthracite Coal Company, Limited, which leased them in 1891 to the H. W. McNeil Company, Limited, the present operator, the coal finding a ready market as far east as Winnipeg. The true anthracite character of the coal is shown by its yielding, on analysis, 87 per cent. of fixed carbon, by its burning with a clear, smokeless, almost flameless glow, and by its ash being white and non-ferruginous.

Mr. Ralph Moore, M.E., of Glasgow, late her Majesty's Inspector of coal mines for Scotland, says in his report of these mines, which he visited in 1889, that there is coal sufficient for an output of 2,000 tons a day for over 100 years. John R. Hoffman and R. C. Luther, of Pottsville, Pa., Mining Engineers of the Philadelphia and Reading Coal Company, have both minutely examined the property and estimate the contents of coal at 150,000,000 of tons minimum.

In 1894 the output was about 65,000 tons, the coal retailing in Winnipeg, 917 miles east of the mines, for $9 per ton for standard sizes and $6.75 for nuts. The rate of the freights over the Canadian Pacific Railway is $5 per ton with a substantial rebate, while the rate from Fort William for American coal is $3 net for 423 miles. The Alberta Railway and Coal Company, operating at Lethridge, raised in 1894 120,000 tons, of which it is estimated about 35,000 tons were exported across the line to Montana. A large portion of the output from this colliery is sold to the Canadian Pacific Railway.

The Dominion Coal, Coke and Transportation Company, at Estevan, in Manitoba, raised in 1894 about 10,000 tons for local consumption.

The following figures give the output of coal in the northwest during the last seven years:

1887	74,152
1888	115,124
1889	97,364
1890	128,953
1891	165,086
1892	131,000
1893	213,015
Total	924,694

Lubricants and Lubrication.

A contemporary remarks that in the balance sheets of manufacturing companies it is usual to place the cost of oil in a line along with several other items, and thus indicate its subordinate financial position. As a matter of fact, the mere cost of the article itself is a small percentage only of the economy, or want thereof, which results from its use. To that peculiar class of economists to whom "low-priced" and "cheap" are convertible terms, this is the only aspect worth considering, but we hope to demonstrate that such a view is entirely fallacious. In the management of a textile factory, for instance, there are numberless instances in which a knowledge of the nature of lubricants would result in cheapness, although the element of "low price" was absent. If the purpose of lubrication be considered rightly, it needs no demonstration that suitability is of more importance than a small cost, because the money economy of the latter is speedily followed by a larger expenditure from other causes.

In designing the working parts of machinery, whether motive, transmissive or operative, one of the main ideas kept in view is the reduction to a minimum of the pressure upon the bearings. The area of the latter is carefully calculated so as to insure the "sweet" working of the journal, or sliding part. Every engineer knows the difficulty of this subject, and gives it his special attention, while being at the same time fully conscious that, owing to the ignorance of the user, all his care may be frustrated and the entire advantage lost. Such revelations as have been made by dynamo-metric tests of contiguous machines, or of similar plants, demonstrate conclusively that the power absorbed in one case is often largely in excess of that taken up in the other. If this

be true in the case of machinery so readily comparable, how much more true is it of that which, owing to the lack of contiguity, cannot be easily tested by comparison. What the total loss is it is not easy to say, but the experience of every thinking and observant user will convince him at least that it is very large. It is with the object of aiding to trace a part of this loss that this article is written, and although it may not contain anything either new or startling, an endeavor will be made to put the subject in a sound and lucid manner. The definition of the terms used always aids in the comprehension of a subject. A lubricant may be defined as any substance which, if interposed between two moving surfaces, lessens the friction created by such motion. Lubrication is, therefore, the interposition between two moving surfaces of some substance tending to reduce the resultant friction. It follows upon these two definitions, if they are accepted as correct, that a perfect lubricant must be capable of interposition between the two surfaces —or, in other words, must separate them—and that perfect lubrication implies such a separation of the surfaces. If these broad distinctions be remembered much will be gained, and it will be seen as we proceed that they always remain true, although their application may appear at times to be obscure.

The first remark which it is necessary to make is that the principles just enunciated have, as a corrollary in practice, the employment of different lubricants for different uses. It is obvious that the same lubricant will not do equally well for the bearing of a slow-running shaft and under a heavy pressure, and that of a quick-running spindle when the pressure is slight. In like manner the lubrication of sliding surfaces which are heated cannot be effected successfully with materials which under ordinary atmospheric conditions would work well. It may, indeed, be said that there are two main divisions on the subject, which require separate consideration. These are the lubrication of cold and of heated surfaces. It is true that in each case the main principle is the same, but it is equally true that the conditions of its application are so diverse as to require individual treatment. It will be readily understood that it is impossible to choose or make a suitable lubricant for any purpose without at the same time taking fully into account the determining factors which make or mar its efficiency. Some of these are found in the nature of the lubricant itself, while others consist of the physical conditions under which it works.

Lubricants, such as are in common use, have different compositions, and are drawn from animal, vegetable or mineral products. All classes of oils obtained from these are not suitable for use as lubricants, and even among those which are often employed there are certain physical peculiarities which unfit them for their purpose. Of the animal oils lard, tallow and sperm are the more frequently employed, tallow being frequently used in a solid state. The vegetable oils used are olive, rape, linseed and castor, while the mineral series are derived either from petroleum or shale. The components of these lubricants vary considerably, and their physical properties also show many differences. It is with the latter that we have more particularly to deal, and except in one or two cases it will not be necessary to refer to their chemical composition at all. The desirable physical properties of any oil used for lubricating purposes may be stated as under: Unctuousness or greasiness; power of resisting the action of the air; freedom from acidity, whether natural or acquired; viscosity; and the absence of inflammability at all temperatures. It will conduce to the purpose in hand if some of these points be at once dealt with briefly, leaving for more lengthy consideration those which are of more importance.

The property which, to use a word adopted by Mr. Veitch-Wilson, may be styled "unctuosity," has a most important bearing upon the subject from the point of view of a reduction of friction. It is difficult exactly to define what it is, but it may be described as that quality which enables a lubricant to adhere to the moving surface, or that upon which it moves, while facilitating the motion by a reduction of friction. A lubricant which creates friction by means of its adherence, under ordinary working conditions, is not unctuous, a remark applying equally to one which leaves the working surfaces so quickly as practically to have no effect in the reduction of friction. The power of adhesion, without an increase of friction, is the one quality which marks an unctuous lubricant. Everyone recognizes the property, although it is difficult to define in words, and will be brought more strikingly into view when other physical characteristics are considered. It is that quality which permits the gliding of the surfaces over each other and the interposed lubricants, and is a most important characteristic when high speeds or considerable pressure exist.

The chemical properties of some oils are such that when exposed to the air they readily absorb oxygen and become thickened or "gummed." Every user knows how evil are the effects produced in this way, and there are few who have not experienced difficulty from this cause. The result of the absorption of oxygen is very marked in almost all oils of either animal or vegetable origin, and a simple method of testing this is that adopted by Nasmith and Albrecht, which consists of allowing a given quantity of oil to run down an inclined plane, noting the distance traveled every day. Tested in this way, the superior fluidity of some oils is speedily shown. Lard, rape and linseed oils have a very short flow, and speedily gum sufficiently to become stationary, while common sperm oil is superior to the better qualities. Lard and linseed oils gummed in five days, rape oil in seven; best sperm oil ceased to flow on the fourth day, while common sperm and Gallipoli olive oils continued to flow on the ninth day. The experience of this test rather contradicts the ordinary belief in the slow gumming properties of refined sperm, but fully confirms the value of Gallipoli as a lubricant. As lard oil has a high setting point and oxidizes slowly, it is probable that it was not pure, cotton seed oil being often used as an adulterant. The same remark applies to the common sperm which may have been mixed with mineral. The evils of gummy oil are well known, and in addition to the friction which they create they are liable to ignite under conditions which are by no means uncommon. If textile waste or other material is saturated with oil and placed in a position where it may be subjected to heat, spontaneous ignition not infrequently takes place.

Acidity, whether material or acquired, is very detrimental, whatever may be the purpose for which the oil may be used. If free acids exist they speedily act upon metallic surfaces with which they come into contact, and a considerable amount of corrosion takes place. This is the fault which exists to a large extent in many animal and some vegetable oils. Tallow is especially faulty in this respect, but olive, rape, lard and neatsfoot oils also contain large quantities of free acids. Although the past few years have witnessed a great advance in the adaptation of mineral oils for lubricating purposes, it is still common to find oils which contain a good deal of acidity used, with an invariably detrimental effect. A number of samples reported upon by Mr. Veitch-Wilson show the following results, the average percentage of free fatty acid being given in each case: Southern sperm, .79; Arctic sperm, 1.84; white whale, 2.22; neatsfoot, 6.91; lard, 4.72; olive, 10.22; refined rape, 2.82 to 4.67. Analyses made by other observers give even smaller percentages of free acid in sperm oil, but generally confirm those of the other oils. This matter is of importance in all cases where oils are used at high temperatures, because then the acids are freed and actively attack metallic surfaces.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, England, Aug. 10th, 1895.

A Movable Gas Stove.—Incandescent Lighting.—Mr. A. Wilson's Experiences with Water Gas.—Mr. Waddell on Gas from Splint, Shale and Oil.—Enterprise in London.

A "feature" in a trades procession that recently perambulated the main thoroughfares of a well-known Yorkshire town, was a complete bakery mounted on a trolley and drawn by horses. This arrangement was conducted under the auspices of the local gas company, and it included a gas cooker, supplied with gas from cylinders of the kind used for carrying compressed oil gas under railway carriages, which were "charged" at the works before starting, together with the requisite furnishings and materials for the manufacture of biscuits and such like delicacies *en route*. Two man cooks carried on these operations, and from time to time showered out the produce of their labors to the crowd. The efficiency, reliability and readiness of the gas stove for instant use were thus prominently advertised, and many who witnessed the show are thinking about gas stoves in a serious manner. Those in search of some new line in the way of advertising gas stoves will, no doubt, take the hint. The present season appears to be a good one for gas cooking apparatus. On every side I hear of increased demands for such appliances, even where no special cause, such as a recent exhibition or cookery demonstration, can be assigned. Coal dealers and others interested in the sale of coal for household uses are complaining of a diminished demand. Probably the recent high prices of coal have something to do with this state of things. Since coal has now returned to something like normal values, several reductions in the price of gas are imminent, and this will add further impetus to the demand for purposes other than lighting.

Many persons were inclined to look with apprehension, about a year ago, at the increasing use of incandescent gas lighting, as likely to affect

the revenues of gas undertakings. They argued that if gas burners using 5 or 6 cubic feet of gas per hour were replaced by other appliances using 2½ to 3 cubic feet, a substantial loss of revenue must be a self-evident fact. This view of matters has not been without its supporters on your side of the Atlantic. Nor is it entirely a new idea. The same notion has been brought out on at least half a dozen earlier occasions. But the accounts for the six months ended June 30th last are now being issued, and people are talking of their experiences, yet I am unable to hear of even one instance in which the apprehensions of a year ago have been recalled. As on the other occasions referred to, subsequent events have proved that they were utterly groundless, and so they have been quietly dropped. The only reason for referring to this point again is simply that it might be chronicled for future use at any time when the alarm might be repeated.

The incandescent light, like all other appliances which improve the intrinsic value of coal gas, has not injured business, but has assisted to some extent in producing the satisfactory results that are generally reported.

Mr. A. Wilson, Manager of the Dawsholm station belonging to the Glasgow Corporation Gas Commissioners, is the President of the North British Association of Gas Managers, and in that capacity has been delivering the usual inaugural address at the annual meeting. The expression "usual" goes no further than the title, and does not in any way indicate the nature of the address. For the number of engineers who have had experience on such a large scale of operations as that at Dawsholm, and can boil down the results of their working into a plain and concise statement that is readily assimilated by the ordinary average intelligence, is not large. Mr. Wilson has produced a gem in the way of presidential addresses. and I do not propose to attempt anything like a general review of it, but simply to refer to his experiences in the manufacture of enriching gas with the aid of a generator, carbureter and superheater of the usual type, using as materials coke, breeze and Broxburn blue oil of .840 specific gravity. The latter is a Scotch paraffine shale oil. Mr. Wilson gives quantities of materials used and cost of making gases of 28½, 33, 36, 41 and 47 candle gas respectively, and finds that the enriching value of the gases is 6 to 10 per cent. greater than the photometrical value. He also drew off samples of gas at various points in the carbureter and superheater. Even at the bottom of the former, the gas had no illuminating value after standing, and the oil condensed out of it was about the same specific gravity as that originally used. The whole of the oil was not broken up and the proper illuminating power attained until near the outlet of the superheater. The consumption of freed carbon fuel increases as the quality of the gas is increased. Commencing with 46.5 lbs. coke and 3 lbs. breeze per 1,000 cubic feet of 28-candle gas, it rises to 53 lbs. coke and 8½ lbs. breeze per 1,000 cubic feet of 47-candle gas. The consumption of oil is fairly regular, being at about the rate of 1 gallon for each 6 candles illuminating power, with the exception of the 47-candle gas, when this ratio falls to 5 candles. There is also a marked agreement in the cost per candle power per 1,000 cubic feet, which is about 0.48d., except in the case of the 47-candle gas, which rises to 0.53d. for the reason just named. Generally the results show that the product may fluctuate between 28 and say 38 candles, without affecting the intrinsic cost. Mr. Wilson spoke highly of the arrangement as an "emergency" appliance, and referring to the carbonic oxide bogey, pointed out that gas of the kind under consideration could be freely used for enriching coal gas without fear of unduly increasing the carbonic oxide in the mixture ; 16 per cent. of 40-candle gas added to 18-candle coal gas for the purpose of producing a 21-candle gas, would only have the effect of adding 2 per cent. or so of carbonic oxide to the 6 or 8 per cent. already present in the coal gas.

The presidential address, however, did not exhaust the enrichment question, for Mr. A. Waddell, of Broughty Ferry, subsequently contributed a paper on gas making from splint, coal and shale, and from splint and oil, working Mr. W. Young's process in the latter case. The first experiment was with ordinary firing under a bench of four retorts; 154 tons of splint and 117 tons of shale were used, and the net cost of the materials, after deducting residuals, works out to 13.8d. per 1,000 cubic feet of 25-candle gas. The yield averaged 8,380 cubic feet per ton of material. In the second experiment, 420 tons splint and 320 of shale were carbonized in a good regenerator setting. The yield rose to nearly 10,000 cubic feet of gas per ton, and the net cost consequently fell to 10.25d. per 1,000 cubic feet of 25-candle gas. In the first experiment no coke remained for sale, but in the second there was a considerable quantity.

This was partly due to using a larger proportion of splint coal, as shale leaves only a refuse in the retort, which costs something for its removal instead of realizing anything. Some Scotch gas managers have never had surplus coke to sell, and look with horror on the idea of adding the disposal of coke to their existing responsibilities. In a third experiment, Mr. Waddell used 2,268 tons of splint, 41 of shale and 161 tons of oil. This mixture gave residuals equal in value to more than half the gross cost. The quality of gas produced was nearly 27 candles, and the yield per ton of material rather less than in the second experiment. But thanks to the aid of the residuals, and to being able to dispense with shale, which costs 50 or 60 per cent. more than coal, the cost per 1,000 cubic feet of 25-candle gas is reduced to just under 12 cents. This is a substantial reduction and should lead many Scotch gas managers to look into the facts and figures of oil versus shale. And those who are able to buy shale cheaply, or have no sale for coke, will find something to ponder over in the difference between the first and the second experiment, which, by a remarkable coincidence, approaches to that between the second and third. This is a difference in the cost of material only, but increasing the yield per ton from 8,380 to 10,000 means a great saving in wages and wear and tear. Carbonizing splint and shale in beds of fours on the old-fashioned plan is evidently a wasteful way of proceeding. It should be added that Mr. Waddell has extended the regenerative system of setting to his oil gas retorts, which is not to be wondered at, after reading about experiments one and two. He speaks highly of the simplicity and ease in working afforded by the Peebles system. By simply increasing the flow of oil to the retorts the quality of the gas produced can be raised expeditiously to any degree. This is very convenient in certain emergencies. One difficulty experienced is the cracking of the retorts. These appliances are made of iron, and as a feature of this system is the supply of a larger quantity of oil to the retort than it is able to properly gasify, the stream of comparatively cold oil, falling on the red hot iron, is apt to cause fracture. This is a simple technical difficulty that can be easily met, and in fact is met by the use of steel plates or false bottoms to receive the oil.

Mr. Waddell was not allowed to carry all his own way in the discussion that followed. But it appeared that the difference of opinion turned upon the varying circumstances in different localities. The diversity appears to be considerable, especially in the matter of coke. Some can dispose of this residual at remarkably good prices, while others seem to think that if they made any at all they would almost have to give it away. In the latter case the saving of coke by the adoption of regenerator furnaces would not be a matter of consequence. But this objection would be of more importance if it were based on actual experience, rather than assumption. Perhaps some of those who at present doubt the existence of a demand for coke in their neighborhood, would be agreeably surprised if they really tried to sell. A good demand for coke can be created in most localities, but it must be worked at like any other business. People will not find out its advantages for themselves.

The Gas Light and Coke Company, of London, have at last thoroughly recognized the fact that new business is worth purchasing, or, in other words, that it is worth while to incur some outlay in the way of pushing trade. Several gas companies in the provinces have long ago recognized this fact, that if they want to establish a good, substantial trade, they must do as other traders do, and go to the customer instead of waiting for the customer to come to them. The success attending their efforts has no doubt attracted the attention of the large London concern, which is now exhibiting most commendable enterprise. At the last meeting of the shareholders, the Chairman, in the course of several remarks on the general state of business and affairs of the Company, mentioned that they had expended £2,650 in fitting up a show room, in a central position, where stoves and appliances of all kinds could be seen in action. He said that the results showed this to be a profitable outlay, as it had largely increased their sale of appliances. The Company are also giving energetic attention to the prepayment or "penny-in-the-slot" system. Their outlay on new meters during the six months ended 30th June, 1895, was £34,900, and for stoves, £24,700. These sums included a large number of automatic meters and stoves for use in connection with the same. From this it is evident that the Gas Light and Coke Company have taken up a thoroughly progressive policy. The South Metropolitan Gas Company, who are usually a little in advance of their neighbors, also record good progress. They commenced the automatic meter in 1890, and have now no less than 32,333 prepayment meters and 20,817 stoves in connection with them. Evidently the stove is an important factor in connection with this new way of selling gas. Both undertakings record a large increase in the sale of gas, and after allowing for the temporary increase in demand during the severe weather of January and February last, there is evidently a good and permanent increase of business.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

AT the annual meeting of the Oakland (Cal.) Gas Light and Heat Company the officers chosen were: Directors, Joseph G. Eastland, J. W. Coleman, James Moffitt, J. T. Wright and D. E. Martin; President, Joseph G. Eastland; Vice-President, James Moffit; Secretary and Treasurer, John A. Britton.

THE correspondent who forwards the above also inclosed the following from the San Francisco (Cal.) *Chronicle* of the 18th of August: "It is refreshing to read of a corporation in these days, without a competitor to prod it up, making reductions in so necessary a commodity as illuminating and heating gas, but this is just what the Oakland Gas Light and Heat Company has done and is doing. In 1877 the corporation made a cut in gas per 1,000 cubic feet, to $3.75; in 1879 it cut to $3.50; in 1881 to $3.25; in 1885 to $3; in 1886 to $2.75; in 1889 to $2.50; in 1894 to $2.25; and now another notice has been issued to the public stating that on and after October 1st the Company will cut its $2.25 rate to $2 per 1,000; but the Company does not stop here, for it cuts gas used in stoves and engines from $2 to $1.75 per 1,000. The new rate applies to the districts of Alameda and Berkeley, as well as to Oakland. This last cut gives the cities on the Eastern bay shore as cheap gas as any other city on the Coast, excepting San Francisco, where the rate for illuminating gas is $1.75 per 1,000; but in Oakland the average of consumers to the mile of pipe is only 58, whereas in San Francisco the average is 200. Coal, too, costs at least 60 cents per ton more in Oakland than in San Francisco. The rate for cooking gas is the same, or rather will be so, as the San Francisco rate."

MR. J. B. CROCKETT, President of the San Francisco Gas Light Company, arrived in New York, from England, per steamship Paris, on August 24th. He is healthy and happy, and it is quite likely that we will soon hear something to the point about the proposed electrical annex for the San Francisco Company.

MR. C. R. FABEN, JR., the wide-awake Superintendent of the Toledo (Ohio) Gas Light and Coke Company, was also in New York last week. Like Mr. Crockett, he is healthy and happy, and, unlike Mr. Crockett, he had to say that he was far from being dissatisfied with the action of his Company in selling out its electrical annex, franchise, public contract, plant, and all else, to a local street railway company.

MR. J. W. STRATTON, former President and Manager of the Valparaiso (Ind.) Gas and Electric Light Company, writing under date of August 22d, says that he has sold all his interest in that Company to Mr. C. A. Sweet, owner of the Valparaiso electric light plant. Mr. Sweet has organized a stock company, to be known as the Valparaiso Co-operative Light Company, which will carry on the gas and electric lighting of Valparaiso without division of interest. Mr. Sweet is President of the new concern, and Mr. E. F. Vanness is Secretary thereof. Meanwhile Mr. Stratton is open for an engagement in the gas business.

AT the annual meeting of the Stockton (Cal.) Gas and Electric Company the officers elected were: Directors, Joseph G. Eastland, Oliver Eldridge, William J. Dutton, F. A. Hihn, G. C. Hyatt, H. E. Adams and Wilson E. Brown; President, Joseph G. Eastland; Vice-President, Oliver Eldridge; Secretary and Treasurer, Alfred T. Eastland.

ON August 16th articles of incorporation were filed by the California Light and Fuel Company, of Los Angeles, Cal., the purposes of the Company being to "operate, sell or otherwise dispose of gas and electric light works, to manufacture and sell gas and electric lights, to operate fuel and power works, to manufacture merchandise of metal and wood, to acquire and dispose of water rights, etc." The Directors named are T. S. C. Lowe, J. M. C. Marble, L. P. Lowe, W. C. Cochran and H. C. Brown. The capital is put at $300,000.

ABOUT a fortnight ago the proprietors of the Flemington (N. J.) Gas Light Company were fined $100 for permitting the drainage from that plant to mix with the waters of Bushkill Creek. The warrant was drawn at the instance of the local Fish Warden, George Dunham, who charged that the refuse was in quantity sufficient to kill the fish with which the creek had been stocked. The Company interposed no defense.

MR. T. R. PARKER, Editor of the Wrinkle Department, which was such a feature of the last meeting of the Pacific Coast Gas Association, writing to us under date of Aug. 22, says:

NAPA, CAL., Aug. 22, 1895.

To the Editor AMERICAN GAS LIGHT JOURNAL: Honor to whom honor is due. In your report* of the Wrinkle Department for the Pacific Coast Gas Association, Wrinkles Nos. 1, 6 and 14 should be credited to Mr. C. E. Jones, and No. 9 to Mr. C. M. Converse; No. 10 was anonymous. Further, the curiosities were not for the banquet, but for the benefit of the Association. With these corrections your published report exceeds in neatness, completeness and quickness (considering the distance) all previous work in this line. Allow me to congratulate you. Long may the JOURNAL shine. The Wrinkle Department practice undoubtedly is causing the meetings of our Associations to become more interesting, since it brings out efforts that emergency or necessity suggests; for most men in any line see things differently, and some even go so far as to think differently, possibly to the verge of originality, and so hit upon a wrinkle that may be quite acceptable, or lead to something better. Yours respectfully, T. R. PARKER.

THE following circular was issued last month by the proprietors of the Wyandotte Gas Company, of Kansas City, Mo.:

"We take pleasure in announcing to our patrons and to the public that our gas rate is reduced to $1.10 per 1,000 cubic feet, with a discount of 10 cents per 1,000 on all bills paid at the office on or before the 10th of the month following that in which the gas was consumed. This rate applies to all gas used in the month of August, for which bills will be rendered September 1st. A 60-candle power gas light now costs less than one-third cent per hour, which price places it within the reach of all. The public is especially requested to consider the advantages gas offers for fuel. It is convenient, clean and economical; there is no soot, no ashes, no smoke, no waste heat, and absolutely no danger. It is now a direct competitor of wood, coal and gasoline, and offers superior advantages over all without the danger. To assist the introduction of gas stoves in general use we keep a large assortment, which are sold at cost. We guarantee all stoves to do satisfactory work. Gas engines are now made in sizes from ½ to 400-horse power, and they furnish power cheaper than any other engine. No boiler, no engineer is required, and almost no attendance. We thank our customers for their past patronage and solicit its continuance. We confidently hope for many new patrons, who are now able to use gas on account of its cheapness."

MR. R. S. TENNANT, the recalcitrant shareholder in the Citizens Fuel and Gas Company, of Terre Haute, who sought to have the assignee's sale of the property and franchises of that Company set aside, on the ground that the proceedings leading up thereto were illegal if not fraudulent, has changed his belief. In any event he has withdrawn his application for a restraining order, and the further understanding is prevalent that he will hereafter work in accord with the McIlhenny syndicate.

THE voters of Jackson, Tenn., have rejected a proposition for an issue of bonds by that municipality, the proceeds wherefrom were to be put to the construction of an electric lighting works, to be operated on public account.

A NEW gasholder is being constructed on the works of the Gardner (Mass.) Gas Company.

THE St. Albans (Vt.) Company is erecting an office building on Kingman street.

"C.," WRITING from Knappton, Ore., on August 20th, says: "The tank steamer Bawnmore, owned by Messrs. Grace & Co., of San Francisco, with a cargo of 5,000 barrels of oil for the Portland (Ore.) Gas Company, arrived at Portland, from Peru, on Friday afternoon, August 16th. This oil is part of the winter supply for the new water gas plant now in course of construction by the United Gas Improvement Company for the Portland Company. This is the first steamer with oil in bulk which has arrived in Portland from a Pacific Coast oil shipping point. The water gas plant above noted is to have a capacity up to 500,000 cubic feet per diem, and work thereon seems to be progressing slowly."

ACTUAL work on the Tampa (Fla.) Gas Company's plant will soon actively commence, and this enterprise, for which (as our readers will probably remember) a franchise was granted last spring, will speedily be in full swing. The only reason that has hindered active work long ere this is the local Florida quarantine laws, prohibiting, for hygienic reasons, excavating the soil during the tropical summer months. These rules, of course, prevented any pipe-laying operations, and without a distributing system it is needless to remark that a producing plant

*See JOURNAL, *ante*, p. 242.

would be of small avail. The "close season" is now fast expiring, so that all energies are being trained by the Tampa gas triumvirate—Messrs. Boardman, Manrara and Knight—to inaugurate the work at the earliest possible moment in order that gas may be supplied to the expectant citizens of Tampa by at least the first of the year, and as much before that time as it can be done. Contracts for pipe and supplies have been made in various directions, and with the United Gas Improvement Company for the works proper, that Company being under agreement to act as engineer for the entire enterprise, and, as contractor, to turn over in due time to the Tampa Company a water gas station complete "to the fence line." The equipment will cover a set of the Philadelphia Company's standard Lowe producing apparatus, of 75,000 cubic feet capacity, a set of four 8 by 8 purifiers, a 30,000-foot holder in steel tank, and the usual accompanying oil tank, station meter, connections and essential small parts. At this rate it seems as though the U. G. I. Company is in a fair way to have more or less of its apparatus in the works of every gas company in Florida, this Tampa instance, if memory serves aright, affording the seventh place out of a possible eleven among the incorporated gas companies of that State.

SINCE Mr. I. C. Copley took charge of the Aurora (Ills.) Gas Light Company a great change has come over the gas spirit of that bustling, handsome Illinois city. Low priced gas of high illuminating value captured the residents, and the clever, energetic Yale boy is reaping the reward of his business tact and his close attention to duty. This year the Company has virtually rebuilt its plant from A to Z, a notable addition being the placing of four benches of 6's of the Parker-Russell type. New buildings house a complete system of purifiers, condensers, scrubbers and boilers, station meter, photometer room, lavatories, and so on—in fact, everything is complete and modern about the new Aurora plant. And while the manufacturing plant proper has received all this attention, it is a further pleasing fact that the distributing plant has been deemed worthy of a good round expenditure, which will be admitted when we say that the pipe system has been extended by the placing of 3 miles of 8-inch, 3 miles of 6-inch, and 3¼ miles of 4-inch pipe. That will do for Aurora, for this year only; as Mr. Copley is confident that other near years are sure to bring added grist to his mill.

A 120-HORSE POWER gas engine has been installed in the electric lighting works, Santa Cruz, Cal.

THE Woonsocket (R. I.) Electric Company has notified the Selectmen of Blackstone, Mass., that it will not furnish the town with arc lights at the rate of 42 cents per arc per night, as ordered by the Board of Gas and Electric Light Commissioners; but the Company made a proposition that may end the controversy and cause the streets of Blackstone to be again lighted after a month of darkness. The Company is willing to furnish lights at 50 cents, the present price on a contract for two years, agreeing to accept a less rate if at any time the price to the city of Woonsocket is reduced. The city of Woonsocket contract expires in two years, when it is probable that the price will be reduced.

THE matter of the public lighting of Sing Sing, N. Y., has been settled. Under the agreement the lighting is to be divided between the Gas Company and the Electric Light Company—the former to be paid $22.50 per lamp per annum, and the latter $22 per lamp. The incandescent electric lamps are of 16-candle power, and the agreement is to last for one year.

MR. JOHN L. KNIGHT, who had been in the employ of the Atlanta (Ga.) Gas Company for 20 years, died at his home in Hopeville, Ga., on the 21st of August.

MR. DAVID S. SIMPSON, for 25 years a collector in the service of the Nassau Gas Light Company, Brooklyn, N. Y., died August 25th. He was in his 81st year, and had been prominent in the Volunteer Fire Department of Brooklyn.

THE following is the text of the bond entered into between J. Frank Aldrich and the authorities of Peoria, Ills., respecting the proposed opposition gas works for that city:

Know all men by these presents, That J. Frank Aldrich, F. W. Horne, D.V. Purington, B. A. Eckhart, John S. Miller, E. R. Brainerd, B. Thomas, D. H. Kochersperger, James Pease, A. L. Thomas and W. H. Wilson, of the city of Chicago and State of Illinois, are held and firmly bound unto the city of Peoria, a municipal corporation of the county of Peoria and State of Illinois, in the sum of $25,000, good and lawful money of the United States of America, to be paid to the said city of Peoria, or to its certain attorneys, officers or agents; for which payment, well and truly to be made, we bind ourselves and our heirs, executors and administrators, jointly and severally, firmly by these presents.

Sealed with our seals, and dated this 19th day of August, in the year of our Lord one thousand eight hundred and ninety-five.

The condition of this obligation is such that *Whereas*, On the 25th day of June, 1895, the City Council of the city of Peoria, Ills., duly passed and adopted an ordinance entitled:

"An ordinance granting to J. Frank Aldrich, his successors and assigns, the right to construct a gas light, fuel and power plant and lay and maintain gas pipes in and along and under the several streets, highways and public places in the city of Peoria, Ills.; and

"*Whereas*, It is provided in and by Section 19 of said ordinance and franchise, 'that the said Frank Aldrich, his successors and assigns, shall file with the City Comptroller of the city of Peoria, within 60 days from the date of the passage of this ordinance, a bond payable to the city of Peoria, in the penal sum of $25,000, with good and sufficient Peoria or Chicago securities thereon, the same to be first submitted to and approved by the City Council of the city of Peoria, Ills.' Now, if the said Frank J. Aldrich, his successors or assigns, will erect sufficient buildings and works for the generating of gas for the use of the city of Peoria and its inhabitants, and put said works in operating order within one year from the 25th day of August, A.D., 1895, and furnish gas for light, fuel and power purposes to the city of Peoria and the inhabitants thereof, upon the terms and at the prices not to exceed those named in said ordinance, and if the said Frank J. Aldrich, his successors or assigns, shall lay gas mains and pipes in continuous connection with the said gas works plant, into and through such streets, avenues, alleys or public places as may be designated by the City Council of the city of Peoria, and along such streets, avenues, blocks and public places in the said city of Peoria, from time to time, as the City Council of said city may direct, in the manner as provided in and by said ordinance; and if the said J. Frank Aldrich, his successors or assigns shall pay all damages sustained by the city of Peoria, or by any person or persons whatsoever, by reason of any exposed condition of said gas works plant, or from any trench dug or pipe laid in or along any of the streets, alleys or public places in said city of Peoria; and if the said J. Frank Aldrich, his successors or assigns, shall not, in any manner combine or confederate with any existing gas company, nor other gas company, person or persons whatsoever in the interest of any existing gas company, or other gas company, person or persons, for the purpose of creating a monopoly of the gas business in the city of Peoria, or for the purpose of regulating the price of gas to consumers; and if the said J. Frank Aldrich, his successors or assigns, shall, in all respects, faithfully comply with and carry out all the terms, conditions and provisions in said ordinance to be by the said J. Frank Aldrich, his successors or assigns, kept and performed, then this obligation to be void; otherwise to remain in full force and virtue."

Modern Electric Power Transmission.

Mr. G. H. Winslow, in describing the electric transmission plant at Pomona, Cal., explains that the system is chiefly remarkable for the long distance over which the energy is transported and the high electrical pressure used, in both of which respects it is, as a commercial apparatus, almost unique.

It comprises a Pelton water power plant working under 390 feet effective head and fitted with a differential governor. The present generators are single-phase alternators of 120 k.w., running at 7,200 alternations, and are two in number. The units of both raising and reducing converters are of 6 k.w. capacity, and are kept cool by immersion in oil. The ratio of transformation is 1,000 : 450, so that in a bank of 20 converters the dynamo pressure required to produce 10,000 volts in the line is 1,110 volts on open circuit and 1,140 under load. There are two independent transmission circuits, each of two No. 7 copper wires. One, 13¾ miles long, supplies Pomona, and the other, 28¾ miles long, supplies San Bernardino. Double-petticoat flint glass insulators are used. The sub-stations are small brick buildings, and the main circuits are connected direct to the reducing converters without switches or other appliances. Stillwell regulators are placed at the sub-stations, instead of at the power house as in the usual arrangement. The distribution from the sub-stations is similar to that ordinarily used with a 1,000-volt alternating dynamo. No attendance is required at the sub-stations, all necessary regulation being effected by the attendant at the power house. The average efficiency of the Pomona circuit is found by test to be about 75 per cent., and an efficiency of over 60 per cent. was attained in an experimental transmission of 100-horse power to San Bernardino, via Pomona—a distance of 42.5 miles. No interruption of service has occurred since the plant began working at 10,000 volts on Feb. 16, 1893.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

MONDAY, SEPTEMBER 2, 1895.

The Seattle and Lake Washington Canal.

The citizens of Seattle, Wash., are jubilant over the beginning of work on a canal which is to connect the Puget Sound with the fresh water lake, Lake Washington. The work, which has been undertaken by the Seattle and Lake Washington Waterway Company, includes the excavation of two waterways, each about 1 mile long and 1,000 feet wide, from deep water through the tide flats of Elliott Bay; two Duwamish waterways connecting the east and west waterways with the mouth of the west channel of the Duwamish river; a canal waterway about 1 mile long and 218 feet wide at low water from the head of the east waterway through the flats eastward to the shore line; a canal through the upland 80 feet wide at the bottom, in a direct line nearly 2 miles to Lake Washington, into which it will open in Wetmore Slough; and the filling to a level of 2 feet above high tide of 1,525 acres of tide land with the excavated material. The two main waterways and the canal waterway are to be excavated to a depth of 26 feet at low tide, the canal itself to a depth of 30 feet at dead low water in the lake, and the Duwamish waterways to a depth of 12 feet at low tide. The amount of material to be excavated is 36,000,000 cubic yards, just about enough to do the filling required.

While the east and west waterways will be 1,000 feet wide, according to the official map of the State Land Commissioners, the space clear for traffic will be only 552 feet between the pier head lines, the remaining 448 feet being allowed for the extension of wharves and slips to such lengths as to accommodate the largest ocean steamers. The construction of waterways on this plan, which would open wharves and slips instead of docks and tidal basins, is in accordance with the most modern ideas of harbor improvements, the revolution in ocean traffic wrought by the use of steamers instead of sailing vessels, the carrying on of land transportation by railroad and the use of machinery for loading and unloading ships having combined to make dispatch in handling cargoes at the same time necessary and possible. Thus the old system of floating a ship into a dock through tidal gates and unloading its cargo on trucks has almost been done away with. Trains are now run right alongside a ship at the wharf and the cargo is transferred from one to the other almost without the touch of a man's hand. With the provision made in the tide land plat for railroad tracks on every wharf and for steamers to run into the slips alongside the tracks, Seattle will have facilities on her waterways for carrying on ocean commerce with speed and economy equal to those of the greatest and most modern ports of America and Europe. In order to secure the greatest length of wharves and slips at a minimum expenditure of water area, the blocks immediately fronting on the waterway are platted at an angle of 45° to the bulkhead line.

The canal waterway through the flats will be crossed by two or three drawbridges to carry the railroads and streets across from north to south. Soon after entering the upland the canal will make its deepest cut of 308.5 feet through Beacon Hill. Either on the side or at the summit of the hill a bridge will be constructed at such a level as to be far above the top of a ship's masts, to carry street railway and other traffic from north to south. Soon after cutting through the hill the canal will enter Rainier Valley, where it makes its smallest cut of 31.4 feet. At this point a drawbridge will carry the Rainier avenue electric railway across. It will then cut through another hill and enter Lake Washington through Wetmore Slough.

The lock will have a width in the clear of 50 feet and a length of 400 feet. The depth on the upper sill will be 30 feet 6 inches at low water on Lake Washington, and on the lower sill 32 feet at high tide and 16 feet at low tide. The lift of the lock will vary from about 16 feet at high tide to about 32 feet at low tide, depending on the stage of water in Lake Washington. This lock will take all commercial deep sea ships that will ever come to Puget Sound, and all sailing ships accompanied by a tug. It will accommodate vessels of 16 feet draft at dead low water, and as the tide rises, vessels of draft up to 36 feet and over will be able to enter or leave the lock. Provisions will be made for building a larger lock whenever the necessity shall arise. The distance from the Lake to the Sound, including the lock, will be about 2 miles, and a ship can readily count on passing through the lock and canal in from one to two hours, depending on its size, a greater rate of speed being allowed for small vessels than for larger ones. It must be remembered that the canal into the lake really begins at the east waterway and the canal waterway, both being integral parts of it, the total distance from deep water in Elliott Bay to deep water in Lake Washington being 20,785 feet.

The excavation of the hill section probably will be made by the hydraulic process—that is, water will be conveyed to the site of the work in pipes under a great pressure. It will then be turned against the earth by means of hydraulic giants, which are simply large nozzles so arranged as to be governed and regulated readily. The material will be washed by these nozzles into flumes, which will convey the semi-liquid mass out upon the tide flats to the place where it is to be distributed.

The Duwamish waterways, by which the east and west waterways will be connected with the Duwamish river, will furnish a deep, straight, navigable channel into the river, and will accommodate the smaller craft running to factories fast growing up on its banks. They will also tend to carry off much more rapidly than at present the flood waters of White and Green rivers, which transform the Duwamish Valley into a great lake every fall and spring. At the same time the lake canal will reduce the permanent level of Lake Washington to the summer level, thereby turning Cedar river into the lake, to be discharged into the canal and relieving the Black and Duwamish rivers of its flood waters.

The vast amount of material to be taken out of the several waterways will be used in making solid ground of 1,525 acres of tide flats directly adjoining the business center of the city, which are now practically useless and have been used hitherto principally as a dumping ground for offal and saw mill refuse. Without such an allied enterprise as the lake canal, it is probable that it would have been many years before the filling of the tide lands would have become a business possibility, but the lead of the canal, the existence of a convenient route for it, and the vast amount of earth to be excavated in digging it furnish all the material needed close at hand. Thus the two enterprises dovetail perfectly. The flats are to be filled to a level 2 feet above high tide line, with a slight grade toward the water for the convenience of drainage, sewerage and the extension of the water system.

About 9 miles of bulkhead will have to be constructed along the harbor rim and the banks of the waterways, and an enormous quantity of material will be used in it. There will be about 16,000 piles, 40,000 tie back poles and 180,000 cords of brush.

The Market for Gas Securities.

The dividend declared for the current quarter on Consolidated shares was the usual 2 per cent., and the stock sold to-day (Friday) at 143 ex., which is to all intent a gain of 3 points for the week. The showing for the quarter was an exceedingly strong one, and we reiterate our advice to buy the stock, believing that it is a purchase at anything this side of a 5 per cent. basis—or 160. Other city shares are strong, save East River, which drags along at 30 bid. Equitable is wanted at 195, and Mutual is also in demand at 171. Standard preferred is a half point off from the quotation of last week, but this is not to be taken as an evidence of weakness, for at 107½ bid, the intrinsic value of the shares seems to be reached. No change in Brooklyn shares is reported. Chicago gas came in at 64½ this noon, and although the outlook was for higher prices, it requires pretty steady vision to foresee the real course of this gassy football. Western, of Milwaukee, is strong, at 64 to 67, and Baltimore Consolidated is a trifle easier, at 62½. Hartford gas is 130 bid. The sale of the Huntington (L. I.) gas works has been postponed, by order of the court, to the 17th inst.

Gas Stocks.

Quotations by Clowe & Nash, Brokers and Dealers in Gas Stocks.

35 Wall St., New York City.

September 2.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	143½	143
Central	500,000	50	150	..
" Scrip	220,000	..	100	..
Equitable	4,000,000	100	195	..
Bonds, 6's	1,000,000	1,000	106	..
" 1st Con. 5's	2,300,000	1,000	113	115
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	171	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	.
Northern	150,000	50	90	91
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	30	32
Preferred	2,000,000	100	54	55½
Bonds	3,500,000	1,000	94	95
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	65	68
Preferred	5,000,000	100	107½	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	108	..
Yonkers	299,650	50	112	..
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	125	..
Citizens	1,200,000	20	65	..
" S. F. Bonds	320,000	1,000	..	101
Equity	2,000,000	10	..	..
" Bonds	1,000,000	..	..	..
Fulton-Municipal	3,000,000	100	175	..
" Bonds	300,000	..	108	..
Peoples	1,000,000	10	90	.
" Bonds, 7's	368,000	..	100	..
" " 6's	94,000	..	98	100
Metropolitan	870,000	100	170	..
" Bonds, 5's	70,000	..	..	..
Nassau	1,000,000	25	225	..
" Ctfs	700,000	1,000	99	100
Williamsburgh	1,000,000	50	210	..
" Bonds	1,000,000	..	107	110
Out-of-Town Companies.				
Bay State	5,000,000	50	19	19½
" Income Bonds	2,000,000	1,000	23	..
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	..	80
2d " " "	3,000,000	1,000	51	55

Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	.....	..	95	..
Chicago Gas Co.	25,000,000	100	64	64¼
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds	7,650,000	1,000	93	93½
Columbus	1,069,000	..	63	66
1st Mortgage	1,085,000	..	91	98
Consumers, Jersey City	2,000,000	100	92	..
" Bonds	600,000	1,000	100½	..
Cincinnati G. & C. Co.	7,000,000	100	206	209½
Consumers, Toronto	1,000,000	50	184½	187
Central, San Francisco	.....	..	95	..
Capital, Sacramento	.....	..	..	41
Consolidated, Baltimore	11,000,000	100	..	62½
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	30¾	..
" Con. Bonds	4,312,000	..	75	..
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	72	74
" Bonds	2,000,000	..	85	..
Hartford	750,000	25	130	135
Indianapolis	2,000,000	..	150	155
" Bonds, 6's	2,650,000	..	105½	..
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind	1,000,000	100	84	86
Bonds	1,000,000	1,000	88	90
Louisville	2,570,000	50	..	130
Laclede, St. Louis	7,500,000	100	27	28
Preferred	2,500,000	100	84	88
Bonds	9,084,400	1,000	97	97¼
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	..
New Haven	.....	25	225	..
Oakland, Cal.	.....	..	45	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	90	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	83	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	71½	72
St. Paul Gas Light Co.	1,500,000	100	68	70
1st Mortgage, 6's	650,000	..	..	..
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	..	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	64½	67
Bonds, 5's	3,556,000	..	95	..
Wilmington, Del.	500,000	50	188	190

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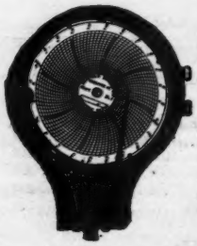

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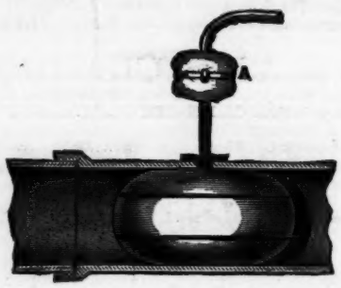

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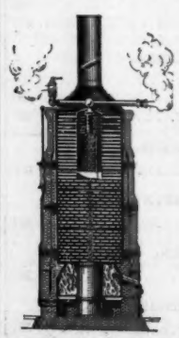

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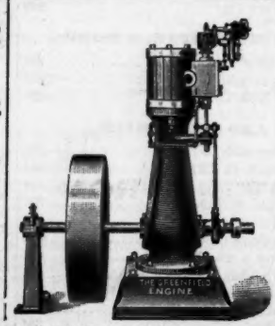

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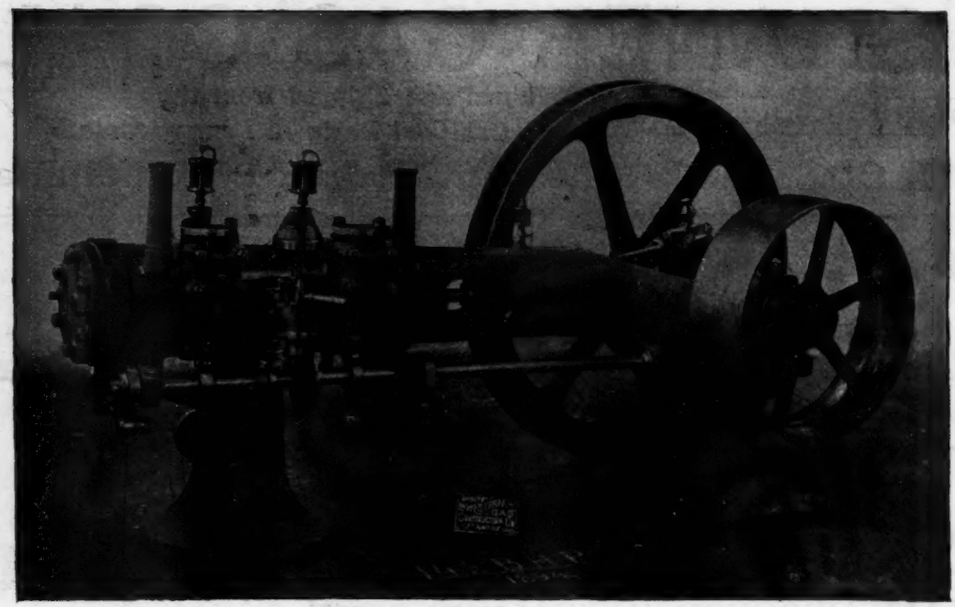

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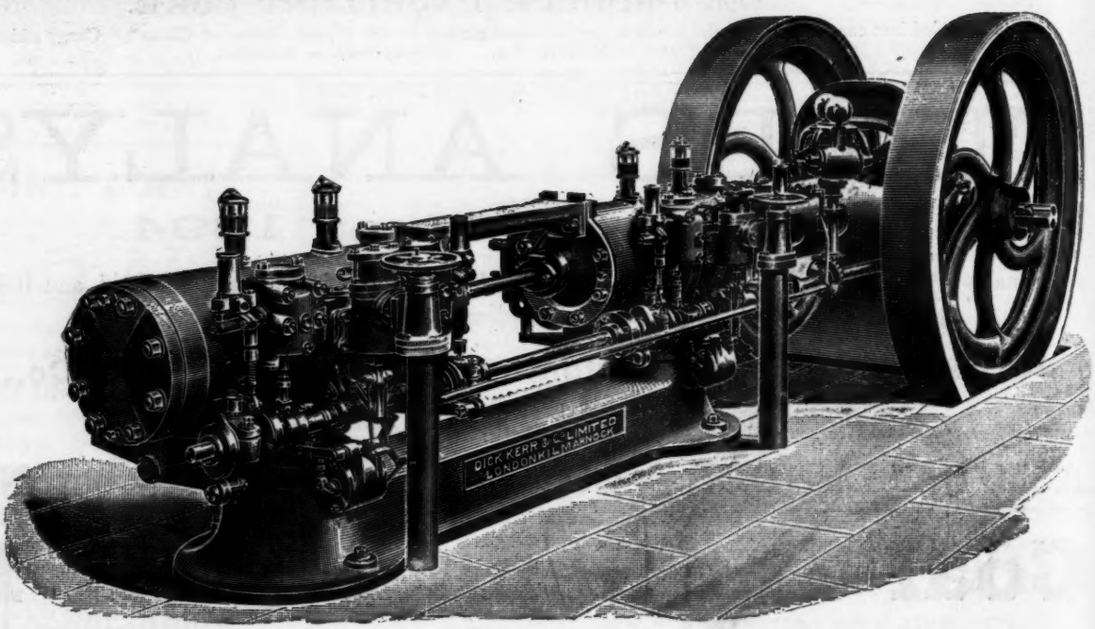

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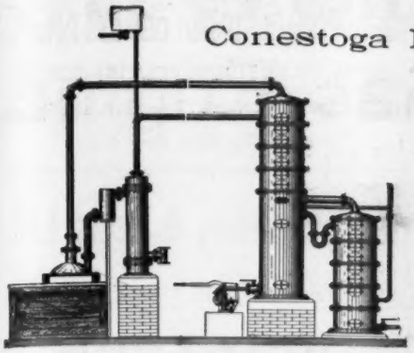

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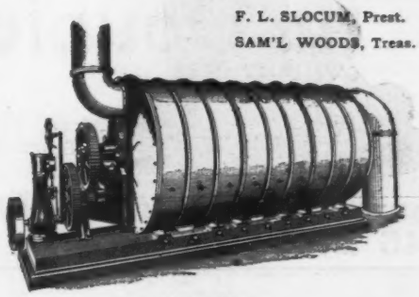

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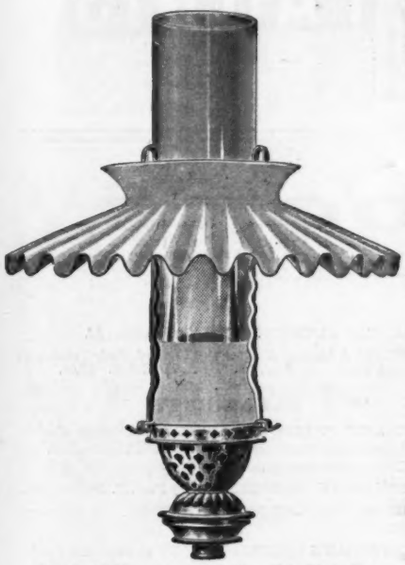

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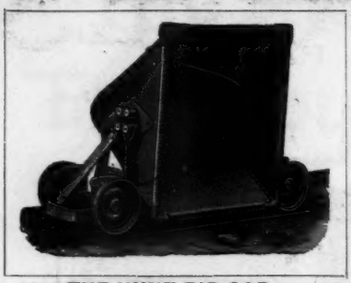

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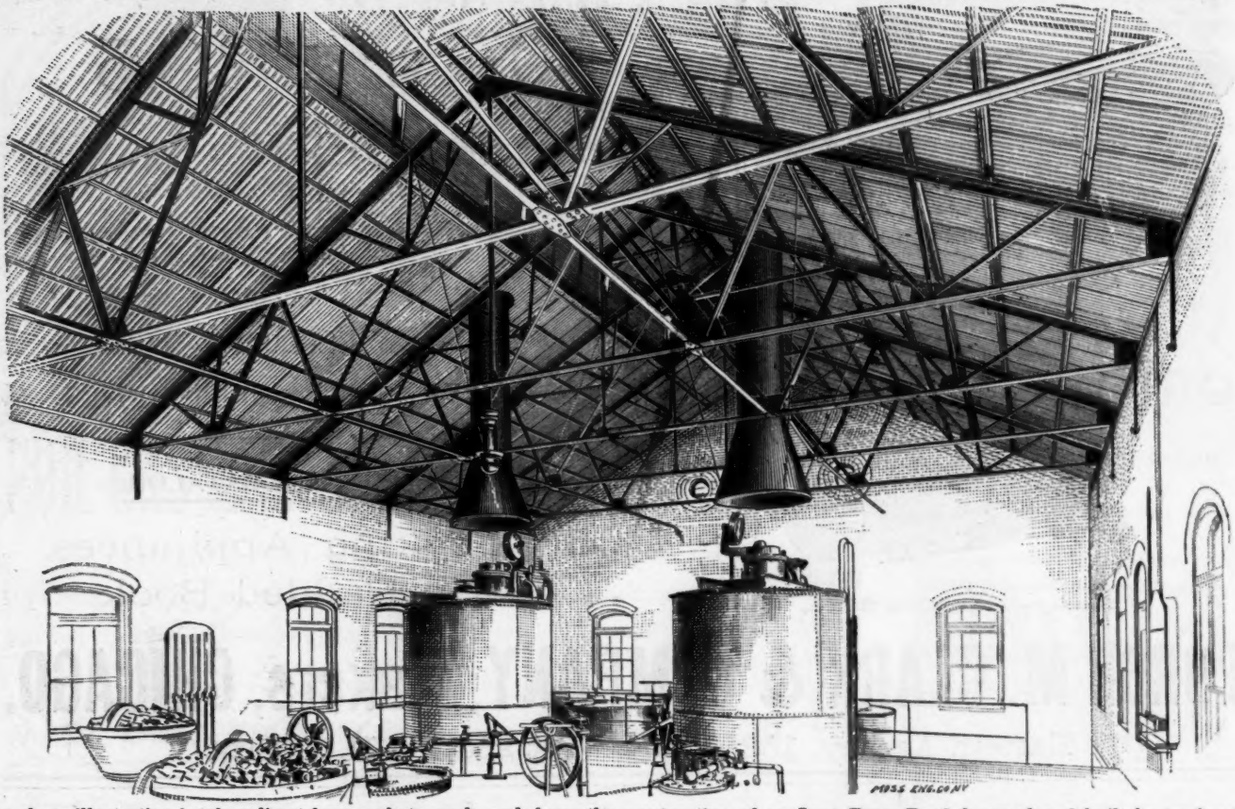

The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for the Providence Gas Light Company, at Providence, R. I. The building is 40 ft. in width by 100 ft. in length, the side walls being of brick and the roof being entirely of iron—that is, iron trusses and iron purlins covered with corrugated iron. The building is ventilated by our Improved Ventilator, extending the full length of the roof, with side shutters opened and closed by cords from the floor. No woodwork is used in any way about the construction of the building.

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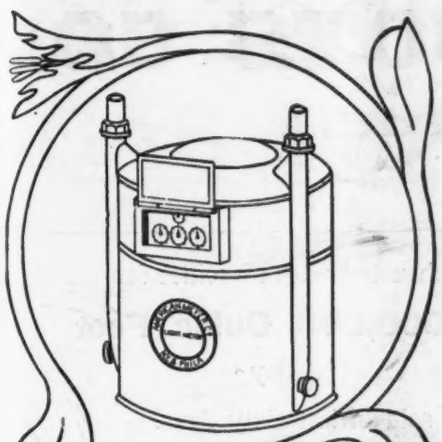

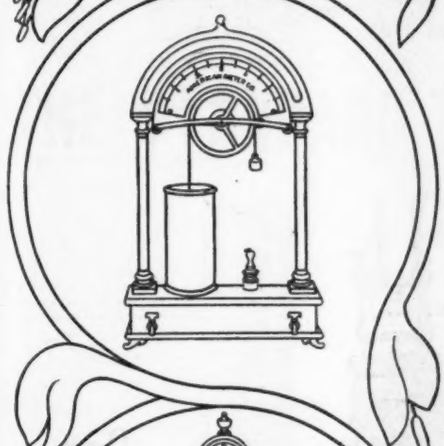

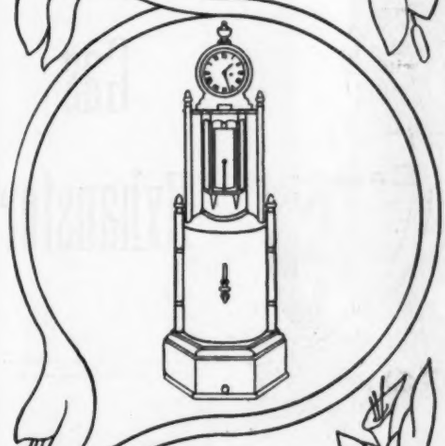

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CHICAGO, ST LOUIS,

SAN FRANCISCO.

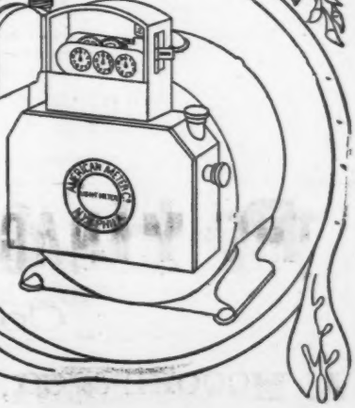
PUBLIC LIGHTING TABLE.

SEPTEMBER, 1895.

Day of Week.	Table No. 1. Following the Moon.			Table No. 2. New York City. All Night Lighting.	
	Date.	Light.	Extinguish.	Light.	Extinguish.
				P.M.	A.M.
Sun.	1	2.40 AM	4.30 AM	6.30	4.20
Mon.	2	No L.	No L.	6.30	4.20
Tue.	3	No L. FM	No L.	6.15	4.30
Wed.	4	No L.	No L.	6.15	4.30
Thu.	5	6.50 PM	8.00 PM	6.15	4.30
Fri.	6	6.50	8.20	6.15	4.30
Sat.	7	6.50	8.40	6.15	4.30
Sun.	8	6.50	9.00	6.15	4.30
Mon.	9	6.50	9.30	6.15	4.30
Tue.	10	6.50	10.10	6.05	4.40
Wed.	11	6.50 LQ	10.50	6.05	4.40
Thu.	12	6.50	11.50	6.05	4.40
Fri.	13	6.50	1.00 AM	6.05	4.40
Sat.	14	6.50	2.20	6.05	4.40
Sun.	15	6.30	4.40	6.05	4.40
Mon.	16	6.30	4.40	6.05	4.40
Tue.	17	6.30	4.40	5.55	4.50
Wed.	18	6.30 NM	4.40	5.55	4.50
Thu.	19	6.30	4.40	5.55	4.50
Fri.	20	6.30	4.40	5.55	4.50
Sat.	21	6.30	4.40	5.55	4.50
Sun.	22	6.30	4.50	5.55	4.50
Mon.	23	7.40	4.50	5.55	4.50
Tue.	24	8.30	4.50	5.40	5.00
Wed.	25	9.30 FQ	4.50	5.40	5.00
Thu.	26	10.30	4.50	5.40	5.00
Fri.	27	11.30	4.50	5.40	5.00
Sat.	28	12.30 AM	4.50	5.40	5.00
Sun.	29	1.40	5.00	5.40	5.00
Mon.	30	2.40	5.00	5.40	5.00

TOTAL HOURS LIGHTING DURING 1895.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	237.00	January	423.20
February	196.40	February	355.25
March	195.50	March	355.35
April	165.30	April	298.50
May	153.40	May	264.50
June	138.20	June	234.25
July	146 30	July	243.45
August	152.50	August	280.25
September	165.10	September	321.15
October	186.10	October	374.30
November	204.10	November	401.40
December	219.30	December	433.45
Total, yr.	2161.20	Total, yr.	3987.45



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per day
sold in last sixty days.

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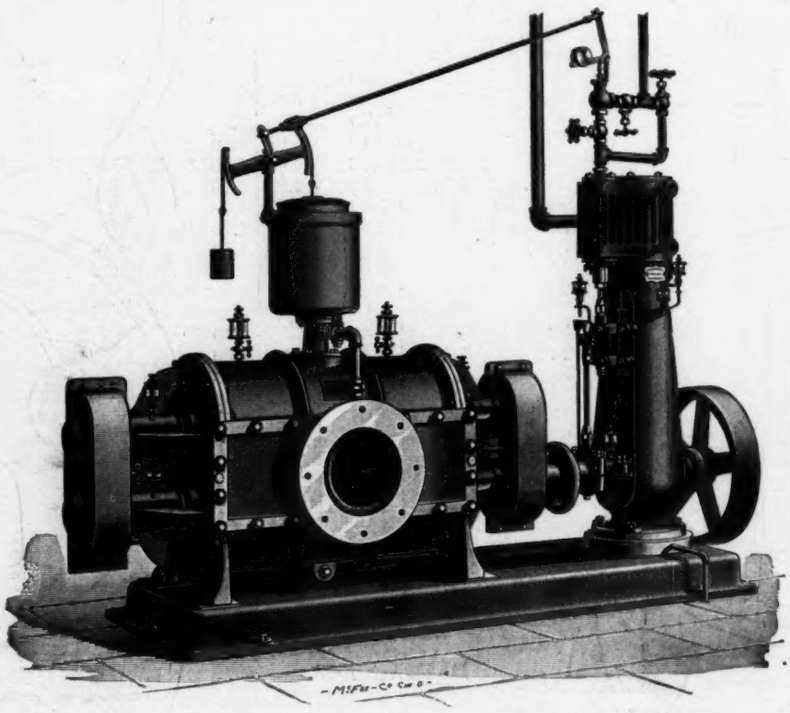

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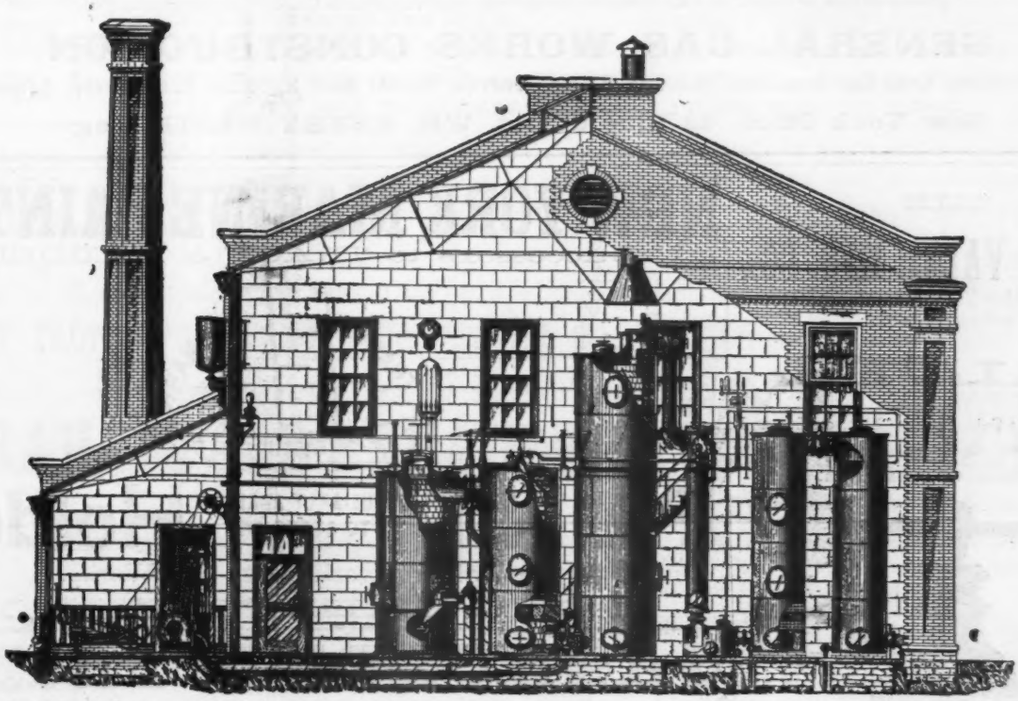

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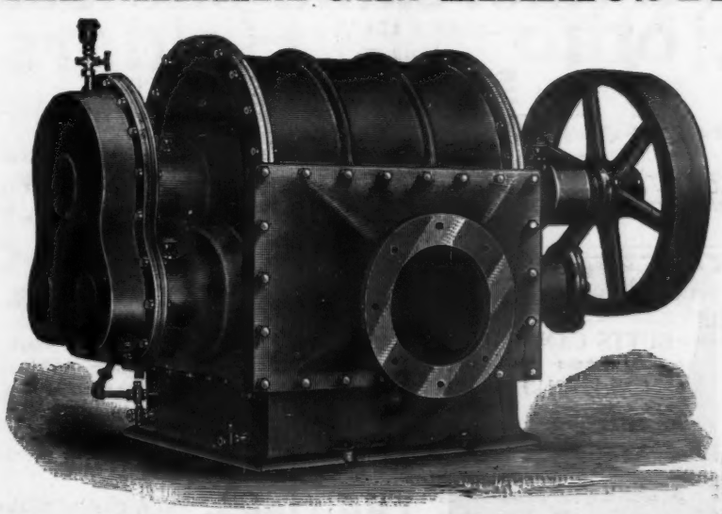

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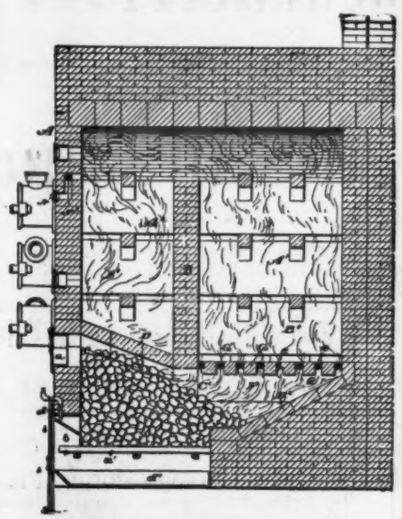

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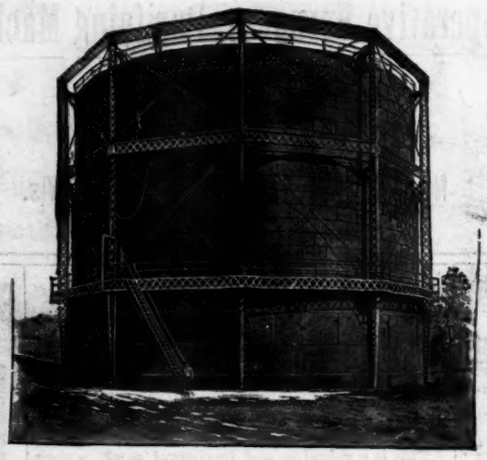

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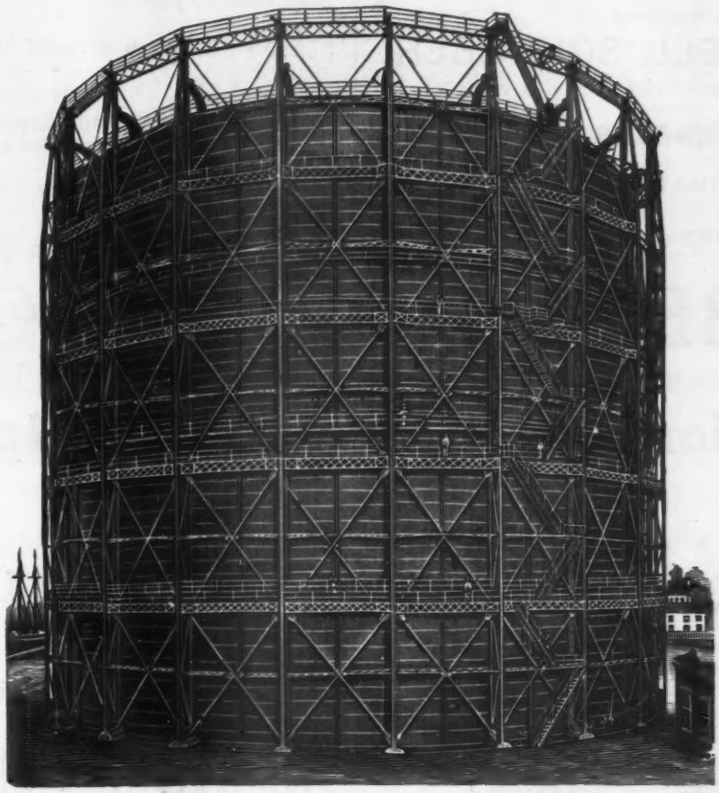

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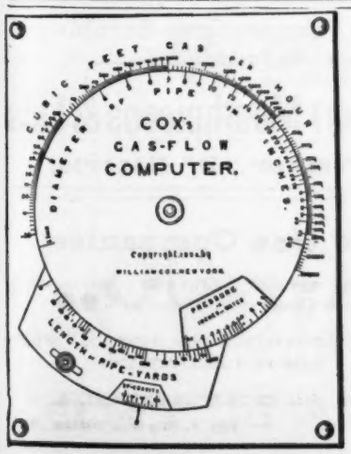

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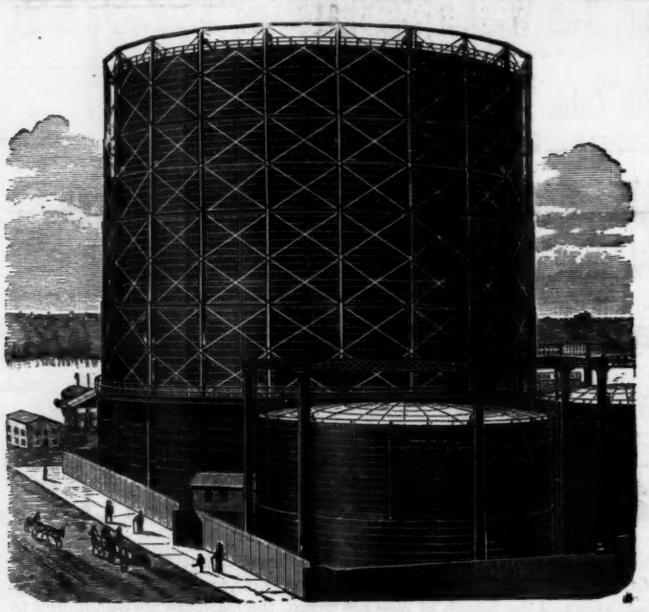

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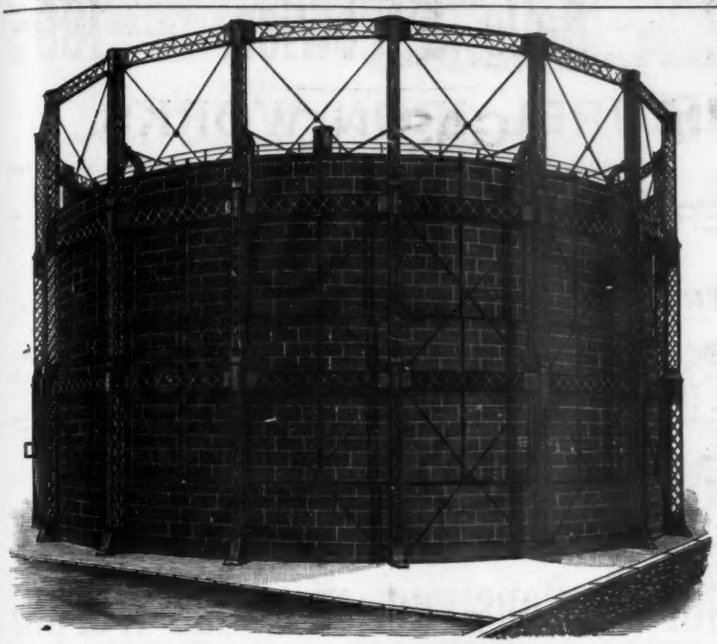

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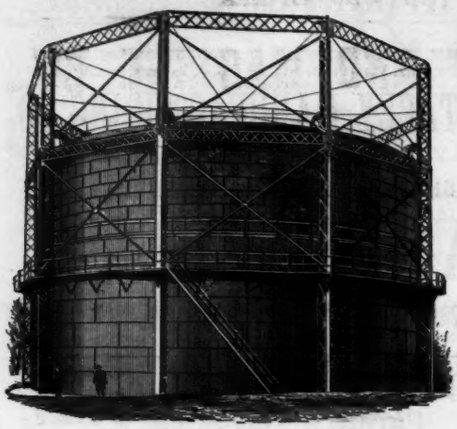

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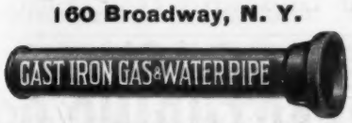

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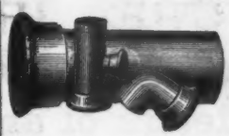

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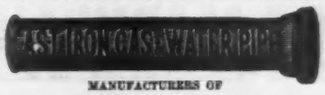

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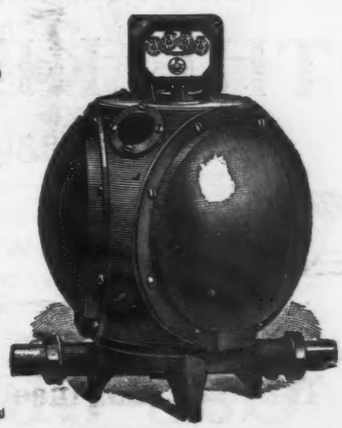

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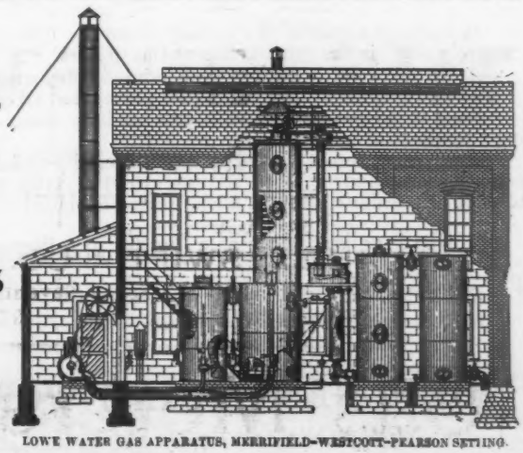

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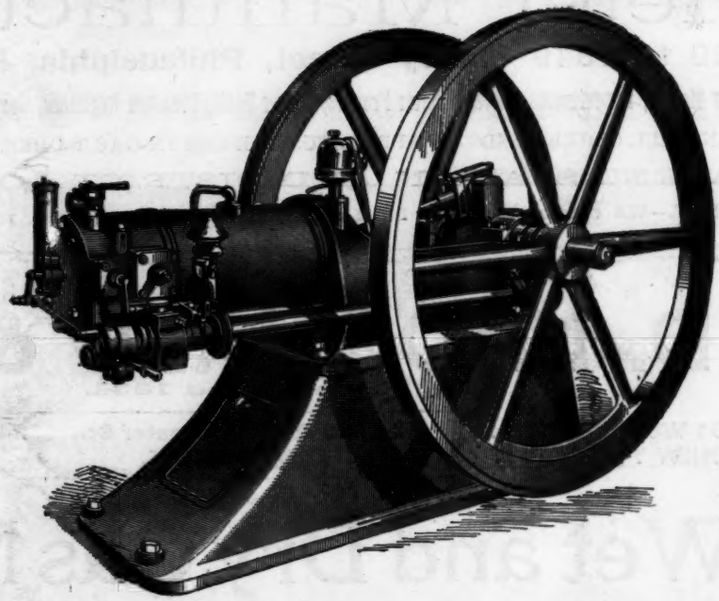

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